RAVALLI COUNTY
LAND SUITABILITY ANALYSIS

A TOOL TO ASSESS DEVELOPMENT SUITABILITY BASED ON EXISTING INFRASTRUCTURE, WATER RESOURCES, WILDLIFE, WORKING LANDS, OPEN LANDS, AND PUBLIC HEALTH AND SAFETY IN RAVALLI COUNTY, MONTANA

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1.0 Introduction

1.1 Project Description

The Land Suitability Analysis (LSA) described in this document is a Geographic Information Systems (GIS)-based tool for evaluating the relative suitability of land for development in Ravalli County, Montana. The purpose of this analysis is to support the development of baseline zoning in Ravalli County. The end product is a generalized map showing areas of the County that are more or less suitable for development. The resulting suitability map is not intended to be used at a site-specific scale and does not constitute a zoning map.

For purposes of this analysis, *suitability* can be defined in terms of physical limitations, existing regulatory restrictions, and the community goals expressed in the Ravalli County Growth Policy (Ravalli County 2002, rev. 2004). Physical limitations such as steep slopes, poorly drained soils or high risk of wildfire make the land less suitable for development. Features subject to existing regulatory restrictions, such as a mapped floodplain or wetland, also pose challenges to development. The goals in the Ravalli County Growth Policy were used as a guide in determining areas of the County that are important community resources, such as open space and wildlife habitat, as well as areas where development should be encouraged, such as near existing towns and infrastructure.

The results of the LSA show areas within the County that are more or less suitable for development based on six categories: (1) existing infrastructure; (2) water resources; (3) wildlife resources; (4) working lands; (5) open lands; and (6) public health and safety. These categories are referred to as *submodels*. These six submodels were selected (1) to ensure that the LSA provides appropriate information to support decisions about zoning based on State Law (sustaining public health and safety provides the legal basis for zoning); (2) to capture goals within the Ravalli County Growth Policy; and (3) to be consistent with criteria used during subdivision review (Ravalli County Subdivision Regulations, Section 3-2-8(b)(v)). Groundwater supply and air quality were originally included as individual submodels, but were removed from the project due to the lack of existing data to accurately represent those categories. Community Planning Committees and local decision-makers will use the results of the LSA along with other information to draw zoning district boundaries.

1.2 Goals and Limitations

As described above, the results of the LSA will be used to support baseline zoning and planning in the unincorporated areas of Ravalli County. Goals of the LSA and appropriate uses of the resulting data include:

- Identifying areas that are suitable for development at a coarse scale;
- Identifying areas that are unsuitable for development at a coarse scale;
- Inventorying existing spatial information available for Ravalli County;
- Using the knowledge and experience of local experts to organize and rank existing spatial information as to its relevance in determining land use suitability;

- Identifying data gaps that may be filled during later planning phases;
- Developing a tool that will help local communities participate in developing meaningful zoning regulations; and
- Providing a foundation for GIS analysis to be used in other long range planning projects occurring in Ravalli County.

Limitations of the LSA include the following:

- Because of the limited resources available, only existing data was utilized;
- Due to the lack of existing data, groundwater supply and air quality were not considered in this analysis;
- The LSA results are not a zoning map, but will be used to support the zoning and planning processes currently taking place in Ravalli County;
- Results and analyses do not support site-specific planning due to limited resolution of some data sets, but are to be used at the countywide scale to support development of baseline zoning;
- The LSA does not make recommendations about how an individual landowner may or may not use their land;
- The LSA does not result in recommendations about where particular land uses (e.g. commercial vs. residential) should be concentrated; and
- Results do not factor in projected population, carrying capacity or housing demand.

Future planning phases may involve more detailed data collection, studies and analysis that would address specific resources like groundwater supply, groundwater/surface water interactions, air quality, and other ongoing efforts like streamside setbacks and highway corridor planning. Most importantly, because the LSA is primarily intended to organize existing spatial information, it will need to be interpreted in light of other information, including non-spatial studies, economic projections, demographic information and results of the public involvement process.

1.3 Document Organization

This document is organized as follows:

- **Section 2. Technical Approach** describes the methods used to develop the six submodels and the final composite model. This section describes data sources used to develop each submodel, including supporting documents and knowledge gathered through local experts and organizations. In addition, this section describes the spatial analysis processes that were used to prepare the data sets, create the individual submodels, and combine all six submodels to create one final model.
- **Section 3. Submodel Descriptions and Criteria** includes a description of each submodel and the rationale for the criteria used to create each submodel.
- **Section 4. Results** includes a description of the final model and how it will be used in the Ravalli County baseline zoning process.
- **Appendix A** includes descriptions of data sets used to develop the six LSA submodels addressed in this report.

- **Appendix B** includes detailed descriptions of reports and documents used during submodel development.
- **Appendix C** describes input from local experts and organizations.
- **Appendix D** describes the criteria used to develop the submodels.

2.0 Technical Approach

2.1 Introduction

This section describes the approach used to develop the six LSA submodels: existing infrastructure; water resources; wildlife resources; working lands; open lands; and public health and safety. Spatial data sets describing each of the six resources were acquired. Additional data from reports and tables were linked to spatial data allowing for more complex and complete analyses. Once initial data sets were acquired, maps of the data were shown to local experts to support discussions about which data were most appropriate to include within each submodel. These experts also helped identify and review draft criteria that outlined how each data set was used in the submodels and the importance of that information in terms of development suitability. This section concludes by describing how the six submodels were combined to create the final LSA.

2.2 Spatial Data Inventory

Spatial data sets were gathered from Ravalli County, other local, state and federal agencies, private organizations and local experts. Data from the following sources were evaluated for use in submodel development:

- City of Hamilton
- Federal Emergency Management Agency (FEMA)
- Montana Audubon
- Montana Cadastral Mapping Project
- Montana Department of Environmental Quality (MT DEQ)
- Montana Department of Natural Resources and Conservation (MT DNRC)
- Montana Department of Transportation (MDT)
- Montana Fish Wildlife and Parks (MTFWP)
- Montana Natural Heritage Program (MNHP)
- National Wetlands Inventory (NWI)
- Ravalli County GIS Department
- Town of Stevensville
- U.S. Department of Agriculture, Natural Resources Conservation Service (USDA NRCS)
- U.S. Department of Interior, Fish Wildlife Service (USDOI, FWS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Forest Service (USFS)
- U.S. Geologic Survey (USGS)

Many of these data sets are available online through the Montana State Library's Natural Resource Information System (http://nris.state.mt.us/), which acts as a clearinghouse for

geographic data in the state of Montana. Other data sets were obtained directly from the sources listed above. A complete list of data sets used in developing the submodels described in this document is provided in Appendix A. Appendix A also includes information about how data were collected, its intended use, and its resolution.

2.3 Supporting Reports and Documents

Relevant reports and other documents were evaluated during the submodel development process. The information in these reports was included to ensure accurate interpretation and use of available data. Some reports do not have associated spatial data but were included because they provide justification for submodel criteria. Summaries of reports reviewed for the analysis are included in Appendix B. The following reports and documents were evaluated:

- 2006 Integrated 303(d)/305(b) Water Quality Report for Montana from the Montana Department of Environmental Quality;
- Bitterroot Valley Agriculture Study from the University of Montana's Center for the Rocky Mountain West;
- Bitterroot Valley Community Wildfire Protection Plan from the Bitterroot Resource Conservation and Development Area, Inc.;
- City of Hamilton Growth Policy;
- City of Hamilton Wastewater Facility Plan;
- Coordinated Implementation Plan for Bird Conservation in Western Montana from the Montana Steering Committee of the Intermountain West Joint Venture;
- Highway 93 Corridor Wildlife Memorandums from the University of Montana School of Law's Land Use Clinic;
- Montana Comprehensive Fish and Wildlife Conservation Strategy from Montana Fish Wildlife and Parks;
- Old Corvallis Road Area 3 Neighborhood Plan, Ravalli County Growth Policy Amendment;
- Ravalli County Airport Influence Area Regulations;
- Ravalli County Airport Layout Plan;
- Ravalli County Growth Policy;
- Ravalli County Pre-Disaster Mitigation Plan from Land and Water Consulting, Inc.;
- Ravalli County Open Lands Bond Program: A Guide for Applicants and Sponsoring Organizations or Agencies from the Ravalli County Open Lands Board;
- Ravalli County Subdivision Regulations;
- Town of Stevensville Comprehensive Plan;
- Town of Stevensville Development Code Book;
- Town of Stevensville Street Master Plan;
- Town of Stevensville Water and Sewer Master Plan; and
- Zoning Ordinance to Limit Height of Objects and Land Use around the Stevensville Airport.

Descriptions of the supporting reports and documents are provided in Appendix B.

2.4 Expert Input

Meetings were held with the following local, state, and federal agencies; local organizations; and individuals to gather their input about which data sets and criteria should be used for each submodel:

- Bitter Root Land Trust;
- Bitterroot Valley Water Manager;
- City of Hamilton;
- Corvallis Sewer District;
- Montana Fish Wildlife and Parks;
- Natural Resources Conservation Service;
- NorthWestern Energy;
- Ravalli County Airport Officials;
- Ravalli County Board of Health;
- Ravalli County Clerk and Recorder's Office;
- Ravalli County Environmental Health Department;
- Ravalli County Fish and Wildlife Association;
- Ravalli County Floodplain Administrator;
- Ravalli Electric Cooperative;
- Right to Farm and Ranch Board;
- Stevensville Airport Officials;
- Town of Darby;
- Town of Pinesdale;
- Town of Stevensville;
- United States Forest Service; and
- Victor Sewer District

A summary of the meetings conducted with various organizations and individuals is provided in Appendix C.

2.5 Criteria Development

Submodel criteria assign rankings or 'Classes' ranging from least to most suitable for development. The submodel criteria were developed by incorporating inherent data set rankings, supporting reports and documents, and input from local experts.

Once initial criteria were developed for each submodel, the results were reviewed by local experts to determine how accurately they represent the resources targeted by each submodel. Through this review process, some initial criteria were slightly modified. For example, after an initial review, the Wildlife Resources Submodel was revised to exclude whitetail deer winter range because that particular species' winter range covered the entire valley. Including whitetail deer winter range in the submodel muted the importance of riparian areas and stream corridors for fish and wildlife, and identified an unreasonably large area of Ravalli County as having low suitability for development with respect to wildlife resources. Other submodels were similarly modified to accurately

reflect the range of conditions in the County. Consequently, the LSA will be a useful tool for delineating zoning boundaries.

2.6 Data Preparation

The spatial data sets were prepared for each submodel using the following techniques:

- Each data set was ***clipped*** to only include data within Ravalli County's geographic boundary. For example, some of the data sets included information for the entire State of Montana. The Ravalli County boundary was used like a cookie cutter to remove any data not within the boundary of Ravalli County.
- Some data sets were ***queried*** to select subsets of the data. Some data sets included information not relevant to the criteria developed for each submodel. For example, distribution data for some wildlife species includes year-round distribution in addition to winter range. For the analysis, only areas with winter range were selected from the overall data set.
- Some non-spatial data were ***joined*** to spatial data as a way to add information to spatial data. For example, tabular data for hydric soils and important farmland soil classifications were joined to soil polygons using unique soil map unit codes.
- Some data sets were ***combined*** to create a summary data layer. For example, land stewardship data (stewardship, ownership, leases and easements) were combined to create a consolidated conservation land data layer.
- Some data sets were ***intersected***, or overlaid, with other data sets. For example, watershed boundaries (polygons) were intersected with linear data sets to select watersheds containing lines that represent water quality impaired streams.
- Some data were analyzed based on their ***proximity*** to other data. For example, parcel data were analyzed to find contiguous parcels with the same ownership that when combined match the size criteria listed in the Open Lands Submodel. These results were further analyzed to determine the proximity of the selected parcels to the consolidated conservation lands data.

2.7 GIS Framework

Developed within a Geographic Information System (GIS), the LSA is built on a grid that divides Ravalli County into one-acre "pixels" or squares (each pixel is approximately 209 feet by 209 feet). Each of the native datasets was standardized to this one-acre grid before being assembled into six separate submodels. Based on the criteria within the submodels, each resulting pixel was assigned a value representing its relative suitability for development. The six submodel values for each pixel were then totaled to arrive at the final LSA value.

3.0 Submodel Descriptions and Criteria

This section outlines details about each of the six submodels. How development suitability classes are assigned within each submodel is best illustrated by the following water resources example (see Section 3.2.3 and Appendix D for complete criteria). Within the Water Resources Submodel, a pixel that overlaps a stream or wetland is placed in Class 1 and receives the lowest development suitability score of 1. A pixel that does not overlap any water resource receives the highest development suitability score, meaning it would be most suitable for development, in terms of that particular resource. If a pixel is located within a watershed where a stream has been identified as having impaired water quality, that pixel will receive an intermediate suitability score. This is because preventing further water quality degradation by limiting development within already impaired watersheds is an important goal of the Ravalli County Growth Policy.

3.1 Existing Infrastructure Submodel

3.1.1 Existing Infrastructure Submodel Description

The Existing Infrastructure Submodel evaluates existing infrastructure to identify areas that are more or less suitable for development. Existing municipal water and wastewater facilities, sewer and water districts, transportation networks, emergency services, utilities, and future plans for the extension of all previously mentioned infrastructure were researched. This submodel was challenging due to the lack of existing information and guidance on where development should be located based on the existence of infrastructure. Table 1 provides a list of data layers used to develop this submodel. Figure 1 displays the results of the Existing Infrastructure Submodel.

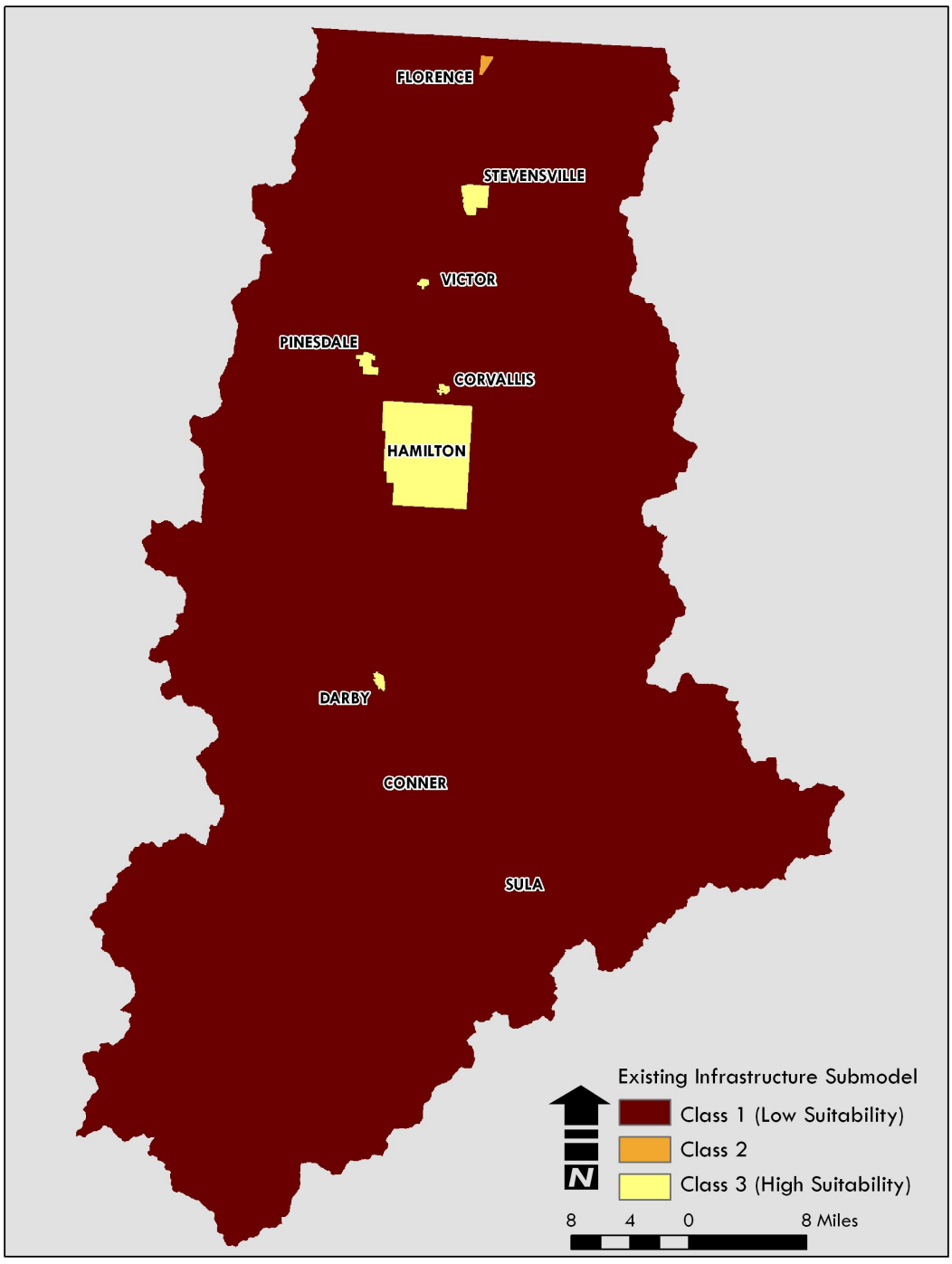


Figure 1. Existing Infrastructure Submodel results showing suitability for development.

3.1.2 Existing Infrastructure Submodel Criteria Rationale

There are three possible classes for the Existing Infrastructure Submodel ranging from least suitable for development (Class 1) to most suitable for development (Class 3) in terms of existing infrastructure.

Class 1 (Low Suitability)
Class 1 areas are located outside of incorporated areas that provide municipal water and wastewater treatment or are outside districts formed to provide public water and/or wastewater treatment. Class 1 areas are also outside of any planned areas for the future extension of incorporated areas or districts. These areas are considered *least suitable for development* because they would most likely be served by individual wells and wastewater treatment systems. Note that the Tin Cup County Water and Sewer District is not excluded from Class 1 because it was created for irrigation purposes and not for public infrastructure.

Class 2 (Moderate Suitability)
Class 2 identifies the area within the Florence Sewer and Water District. This is considered to be *moderately suitable for development* because the district has been formed, but it is not known whether or not the community wants public water and/or wastewater treatment facilities.

Class 3 (High Suitability)
Class 3 areas are within the 20-year Planning Area from the *City of Hamilton FY 2004-2008 Growth Policy*; the Planned Growth Area from the *Town of Stevensville Street Master Plan, 2001;* the incorporated area of the Town of Darby, the incorporated area of the Town of Pinesdale, the Corvallis Sewer District, or the Victor Sewer District. These areas are considered *most suitable for development* because they are currently or have a higher likelihood of being served by municipal or public water and/or wastewater treatment facilities provided by a district.

The 20-Year Planning Area from the *City of Hamilton FY 2004-2008 Growth Policy* was recommended as *most suitable for development* by the City of Hamilton Planner. It encompasses the incorporated area of Hamilton, the Hamilton Sewer Planning Area from the *2006 Wastewater Facility Plan* and the Old Corvallis Road Area 3 Neighborhood Plan Amendment to the Ravalli County Growth Policy.

The Planned Growth Area from the *Town of Stevensville Street Master Plan, 2001* was used because it is the most current planning area. It encompasses the incorporated area of Stevensville; the Master Planned Area from the *Town of Stevensville Water and Sewer Master Plan, 2003*; and the Stevensville Extraterritorial Zoning Boundary from the *Town of Stevensville Comprehensive Plan, 2002* and *Development Code Book, 2007*.

The incorporated areas for Darby and Pinesdale were used because they have no planning areas for future annexation. The areas within the Corvallis Sewer District and Victor Sewer District were used because there are no planning areas for future extension of services.

Following is an outline of existing infrastructure in Ravalli County and why certain elements were not included in the Existing Infrastructure Submodel:

Incorporated Areas

Ravalli County has four incorporated areas including the City of Hamilton, the Town of Stevensville, the Town of Darby, and the Town of Pinesdale. As stated above, data from the City of Hamilton and the Town of Stevensville were included in the submodel.

According to the Mayor of Darby, the Darby Planning Board has created a draft map outlining potential growth of the city limits. Because the map is in draft form and has not been through a public process or officially adopted, this information was not used in the submodel. The existing incorporated area of Darby was included in the analysis.

The Chairman of the Selectmen for the Town of Pinesdale stated that there are no plans for expanding town limits at this time. The town recently received a grant to improve their public water system. The existing incorporated area of Pinesdale was included in the analysis.

Sewer and Water Districts for Unincorporated Areas

There are two active sewer districts with wastewater infrastructure including the Corvallis Sewer District and the Victor Sewer District. There is a Florence Sewer and Water District, but there is no infrastructure at this time. The boundaries of the Corvallis, Victor, and Florence districts were used in the submodel. The Tin Cup Water and Sewer District was created for irrigation purposes and is not associated with any water or wastewater facilities so it was not incorporated into the submodel.

Ravalli County Airport in Hamilton

The Ravalli County Airport is located off Eastside Highway and Airport Road east of Hamilton. There are adopted *Ravalli County Airport Influence Area Regulations,* an Airport Influence Area (AIA), and *Ravalli County Airport Layout Plan.* These documents outline height restrictions. Since the LSA will determine suitability for development intensity and not suitability for various building heights, these zones were not included in the analysis.

There are land use restrictions in Land Use Districts A and B noted in the *Ravalli County Airport Influence Area Regulations*. Digital files of the land use districts are not currently available. There are hard copy maps in the Clerk and Recorder's Office and the Airport Manager is working with Morrison-Mairle to obtain the digital files.

The County is in the process of performing an Environmental Assessment to improve and relocate the existing runway facilities. Since there is no available digital data for the land use districts and there is the potential for the runway to be relocated, Ravalli County Airport data was not included in this analysis.

Stevensville Airport

The Stevensville Airport is located northeast of Stevensville off Stevensville Airport Road. There are regulations titled *Zoning Ordinance to Limit Height of Objects and Land Use around the Stevensville Airport, 2001*. While the document lists height and potentially light restrictions, the specific guidance on land uses or development densities surrounding the Stevensville Airport are not clear. Staff was not able to determine how development suitability should be rated in the area surrounding the airport so Stevensville Airport data was not included in the analysis.

Transportation Networks

There are two airports, which were mentioned above. Montana Rail Link has a commercial freight railroad line that traverses the County along Highway 93.

The County has a road network of State highways, County-maintained roads, private roads, and Forest Service roads. Because the County does not have a transportation plan, there was no guidance on where development should be located based on the existing road networks. It does not seem logical to rate existing transportation networks as "high suitability" when historically, road improvements have been made based on existing need and not where development should be located. Existing transportation data was not used in the analysis.

Emergency Services (Law Enforcement, Fire, Ambulance)

The Ravalli County Sheriff's Office is located in Hamilton. There are also law enforcement services based out of Hamilton, Stevensville, and Darby. Most of the County is serviced by one of the volunteer rural fire districts or a municipal fire department. Marcus Daly Memorial Hospital EMS and Missoula Emergency Services provide ambulance services to the County. We were unable to obtain digital files of emergency response data to determine areas of the County that are more or less suitable for development based on the amount of time it takes emergency services to respond.

Electric and Gas (NorthWestern Energy and Ravalli Electric Cooperative (REC))

REC does not have existing GIS data of their service network. A representative of REC stated there is nothing that would prevent a property from getting service from REC. NorthWestern Energy does have GIS data of their service network. A representative from NorthWestern Energy stated that they will supply any property with service. It is easier to connect new development when there are existing lines in the vicinity. Other existing infrastructure, such as public water and sewer, would indicate that there is a higher level of power capacity in that area. Because location did not appear to be a factor in determining whether or not a property will be served by a utility company and because a high level of capacity usually coincides with existing sewer and water lines, existing power lines/capacity were not included as an additional data set in the submodel.

3.1.3 Existing Infrastructure Submodel Criteria

Table 1 below lists the criteria used to evaluate each class described above for the Existing Infrastructure Submodel.

Table 1. Existing Infrastructure Submodel criteria.

	Data Layer [1]	Class 1: (*If **all** below are true*)	Class 2: (*If **all** below are true*)	Class 3: (*If **any** below are true*)
A	Sewer Districts	'Name' = 'Tin Cup County Water and Sewer District'[2]	'Name' = 'Florence Sewer and Water District'	'Name' = 'Corvallis Sewer District' or 'Victor Sewer District'
B	20-Year Planning Area for Hamilton	Not Present	Not Present	Present
C	Planned Growth Area for Stevensville	Not Present	Not Present	Present
D	Incorporate Areas	Not Present	Not Present	Present

[1] Data layers are described in detail in Appendix A.

[2] Class 1 only includes the Tin Cup County Water and Sewer District because it was created for irrigation purposes. There are no public water or wastewater treatment facilities associated with this district.

3.2 Water Resources Submodel

3.2.1 Water Resources Submodel Description

The water resources submodel evaluates surface water and shallow groundwater resources in Ravalli County to identify areas that are more or less suitable for development. The water resources submodel includes the following data layers: streams; wetlands; lakes; ponds; reservoirs; riparian areas; the 100-year floodplain; and irrigation ditches. Table 2 provides a complete list of data sets used to develop this submodel. Other aspects of water resources, such as groundwater availability and the interaction of surface water and groundwater with respect to water quality were not evaluated as part of this submodel. However, these other aspects of water resources are identified as data gaps that should be filled to support future land use planning efforts. Future steps may include Ravalli County Planning and Environmental Health Departments working closely with Montana DEQ and Montana Bureau of Mines and Geology to create spatial data that characterizes groundwater resources throughout Ravalli County. Figure 2 displays the results of the Water Resources Submodel.

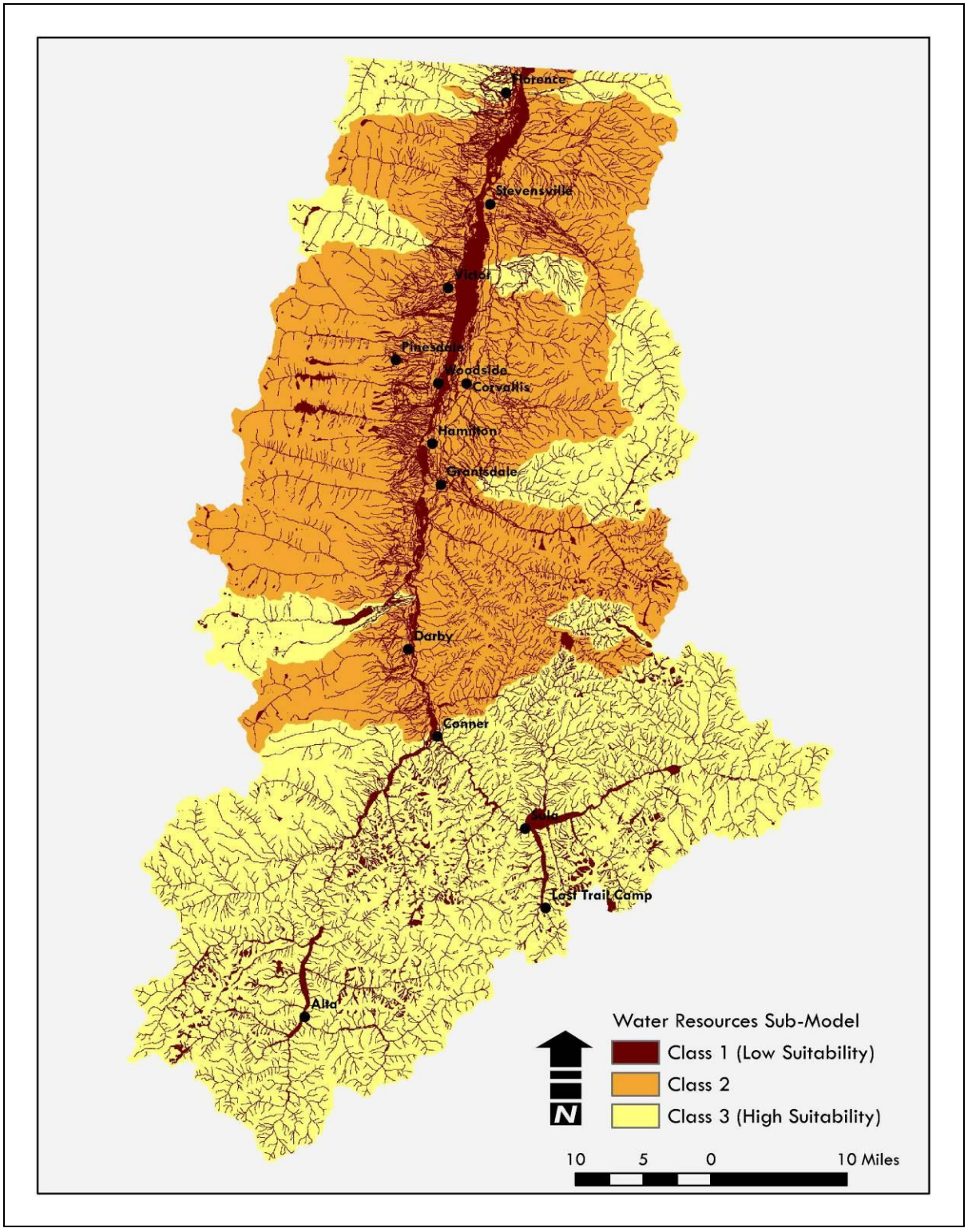


Figure 2. Water Resources Submodel results showing suitability for development.

3.2.2 Water Resources Submodel Criteria Rationale

There are three possible classes for the Water Resources Submodel ranging from least suitable for development (Class 1) to most suitable for development (Class 3) in terms of water resources.

Class 1 (Low Suitability)
Class 1 areas are where surface water and shallow groundwater resources occur in Ravalli County. These areas are considered *least suitable for development* because development would directly impact a water resource.

Class 2 (Moderate Suitability)
Class 2 identifies the locations of areas that either contain or may indirectly influence water resources, such as the 500-year floodplain and watersheds that include impaired water resources. In these areas, which are considered to be *moderately suitable for development,* development may pose a higher risk to nearby water resources than areas that are not near impaired water resources.

Class 3 (High Suitability)
Class 3 areas are considered *most suitable for development* in terms of water resources. These pixels indicate areas where surface water or shallow groundwater resources are not present or areas that do not indirectly influence water resources according to data sets used in the LSA. These are the areas not included in Class 1 or Class 2. Additional analyses completed outside the LSA may identify other areas where development should be limited, such as areas that may be more vulnerable to groundwater contamination.

3.2.3 Water Resources Submodel Criteria

Table 2 below lists the criteria used to evaluate each class described above for the Water Resources Submodel. Appendix D shows how criteria were used to develop the submodel, and each data set is described in more detail in Appendix A.

Table 2. Water Resources Submodel criteria.

	Data Layer [1]	Class 1: (*If **any** below are true*)	Class 2: (*If **all** of A through J are true **and either** K or L is true*)	Class 3: [2] (*If **all** below are true*)
A	National Hydrography Dataset – linear water features	'FType' = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'	'FType' not = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'	'FType' not = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'
B	National Hydrography Dataset – stream or river areas	'FType' = 'StreamRiver'	'FType' not = 'StreamRiver'	'FType' not = 'StreamRiver'
C	National Hydrography Dataset – lakes, ponds, reservoirs or wetlands	'FType' = 'LakePond', 'Reservoir', or 'SwampMarsh'	'FType' not = 'LakePond', 'Reservoir', or 'SwampMarsh'	'FType' not = 'LakePond', 'Reservoir', or 'SwampMarsh'
D	National Wetlands Inventory (2007)	Present	Not Present	Not Present
E	Bitterroot Wetlands Project	Present	Not Present	Not Present
F	U.S. Forest Service Wetlands	Present	Not Present	Not Present
G	Riparian	Present	Not Present	Not Present
H	100 Year Floodway or Flood Fringe	Present	Not Present	Not Present
I	Hydric Soils	>50% of map unit components are hydric	<=50% of map unit components are hydric	<=50% of map unit components are hydric
J	Irrigation Ditches (1958)	Present	Not Present	Not Present
K	500 Year Hazard	NA	Present	Not Present
L	6th Code HUC subwatersheds with streams or stream reaches on the 2006 303(d) list	NA	If stream or stream segment listed as impaired occurs in subwatershed boundary	No stream or stream segment listed as impaired occurs in subwatershed boundary

[1] Data layers are described in detail in Appendix A.
[2] Includes all areas that are not represented by the other two classes.

3.3 Wildlife Resources Submodel

3.3.1 Wildlife Resources Submodel Description

The Wildlife Resources Submodel evaluates wildlife distributions and habitat resources in Ravalli County to identify suitable and unsuitable areas for development. The Wildlife Resources Submodel focuses on the habitat and distribution of fish, wildlife, and birds. Streams, riparian areas, elk and mule deer winter range, and Important Bird Areas (IBAs) identified by Montana Audubon are examples of data included as part of the Wildlife Resources Submodel. Table 3 provides a complete list of data sets used to develop this submodel. Figure 3 displays the results of the Wildlife Resources Submodel.

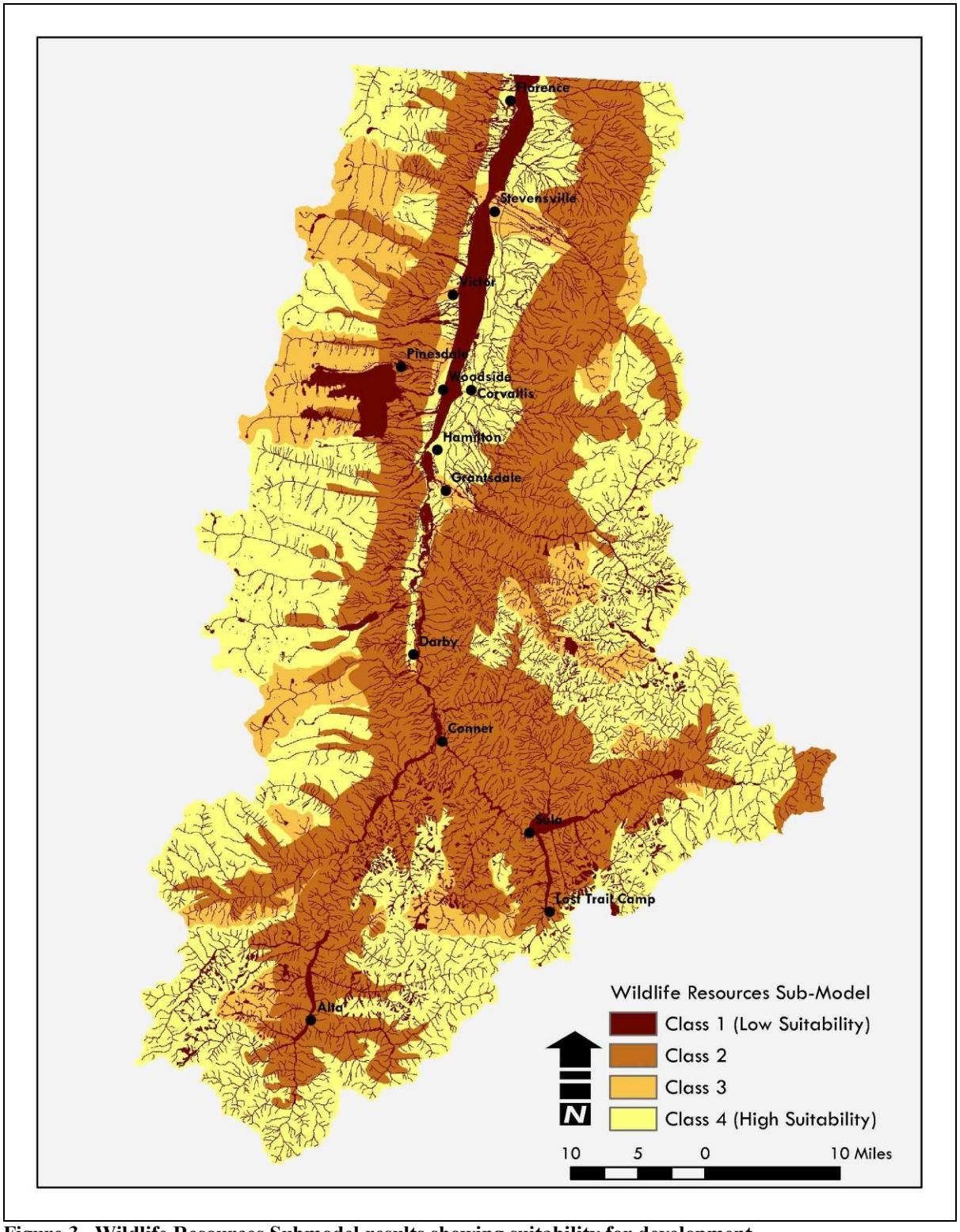


Figure 3. Wildlife Resources Submodel results showing suitability for development.

3.3.2 Wildlife Resources Submodel Criteria Rationale

There are four possible classes for the Wildlife Resources Submodel analysis ranging from least suitable for development (Class 1) to most suitable for development (Class 4) considering wildlife resources. Many wildlife species use land throughout Ravalli County for year-round habitat and spatial data exists showing these ranges. Data sets that show habitat for a species throughout the entire County were not included in the analysis because they do not show any area as being different from any other area.

Class 1 (Least Suitable)
Class 1 identifies important habitat features such as streams, wetlands and riparian areas in Ravalli County that provide the most important habitat for wildlife and are therefore *least suitable for development*.

Class 2 (Less Suitable)
Class 2 identifies winter range for elk, mule deer, moose and other species in Ravalli County that represent other important habitat for wildlife and are therefore *less suitable for development*.

Class 3 (Moderately Suitable)
Class 3 identifies the locations of wildlife related resources, such as the 100 and 500-year floodplain and watersheds that include important fish habitat. These areas are considered *moderately suitable for development*.

Class 4 (Most Suitable)
Class 4 is considered the *most suitable for development* and includes all areas that are not identified in Classes 1, 2 or 3.

3.3.3 Wildlife Resources Submodel Criteria

Table 3 below lists the criteria used to evaluate each class described above for the wildlife resources submodel. Appendix D shows how data were used to develop the submodel, and data sets are described in more detail in Appendix A.

Table 3. Wildlife Resources Submodel criteria.

	Data Set [1]	Class 1: (*If **any** below are true*)	Class 2: (*If **all** of A through J are true **and any** of K through O are true*)	Class 3: (*If **all** of A through O are true **and either** P or Q is true*)	Class 4[2] (*If **all** below are true*)
A	National Hydrography Dataset – linear water features	'FType' = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'	'FType' not = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'	'FType' not = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'	'FType' not = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path'
B	National Hydrography Dataset – stream or river areas	'FType' = 'StreamRiver'	'FType' not = 'StreamRiver'	'FType' not = 'StreamRiver'	'FType' not = 'StreamRiver'
C	National Hydrography Dataset – lakes, ponds, reservoirs or wetlands	'FType' = 'LakePond', 'Reservoir', or 'SwampMarsh'	'FType' not = 'LakePond', 'Reservoir', or 'SwampMarsh'	'FType' not = 'LakePond', 'Reservoir', or 'SwampMarsh'	'FType' not = 'LakePond', 'Reservoir', or 'SwampMarsh'
D	Riparian	Present	Not Present	Not Present	Not Present
E	National Wetlands Inventory (2007)	Present	Not Present	Not Present	Not Present
F	Bitterroot Wetlands (2005)	Present	Not Present	Not Present	Not Present
G	U.S. Forest Service Wetlands	Present	Not Present	Not Present	Not Present
H	Bitterroot Important Bird Area	Present	Not Present	Not Present	Not Present
I	Blodgett Important Bird Area	Present	Not Present	Not Present	Not Present
J	National Wildlife Refuges	Present	Not Present	Not Present	Not Present
K	Bighorn sheep distribution	NA	'BSH_USE' contains 'W'	'BSH_USE' does not contain 'W'	'BSH_USE' does not contain 'W'
L	Mule deer distribution	NA	'Class' contains 'D'	'Class' does not contain 'D'	'Class' does not contain 'D'
M	Moose distribution	NA	'USE' contains 'W'	'USE' does not contain 'W'	'USE' does not contain 'W'
N	Mountain goat distribution	NA	'USE' contains 'W'	'USE' does not contain 'W'	'USE' does not contain 'W'
O	Elk distribution	NA	'WCRUCIAL' = 'C' or 'WINHAB' = 'Y'	'WCRUCIAL' not = 'C' or 'WINHAB' not = 'Y'	'WCRUCIAL' not = 'C' or 'WINHAB' not = 'Y'
P	6th Code HUC subwatersheds	NA	NA	If a subwatershed contains core critical habitat for bull trout OR a fluvial cutthroat spawning stream OR a important rainbow and/or brown trout spawning tributary	Subwatershed does not contain core critical habitat for bull trout OR a fluvial cutthroat spawning stream OR a important rainbow and/or brown trout spawning tributary
Q	Floodplain (100 or 500 year flood fringe or 100 year floodway)	NA	NA	Present	Not Present

[1] Data sets are described in detail in Appendix A.

[2] Includes all areas that are not represented by the other three classes.

3.4 Working Lands Submodel

3.4.1 Working Lands Submodel Description

The Working Lands Submodel evaluates existing working lands including farm and ranch land and timber production lands in Ravalli County to identify areas more or less suitable for development. The Working Lands Submodel focuses on existing working lands, and the irrigation and soils that support working lands in Ravalli County. Soils are differentiated based on a classification of farmland soils by the Natural Resources Conservation Service as part of the soil survey for the Bitterroot Valley Area. The farmland soils classification includes Prime Farmland, Prime Farmland if Irrigated, Farmland of Statewide Importance, and Farmland of Local Importance. Table 4 provides a complete list of data sets used to develop this submodel. Figure 4 displays the results of the Working Lands Submodel.

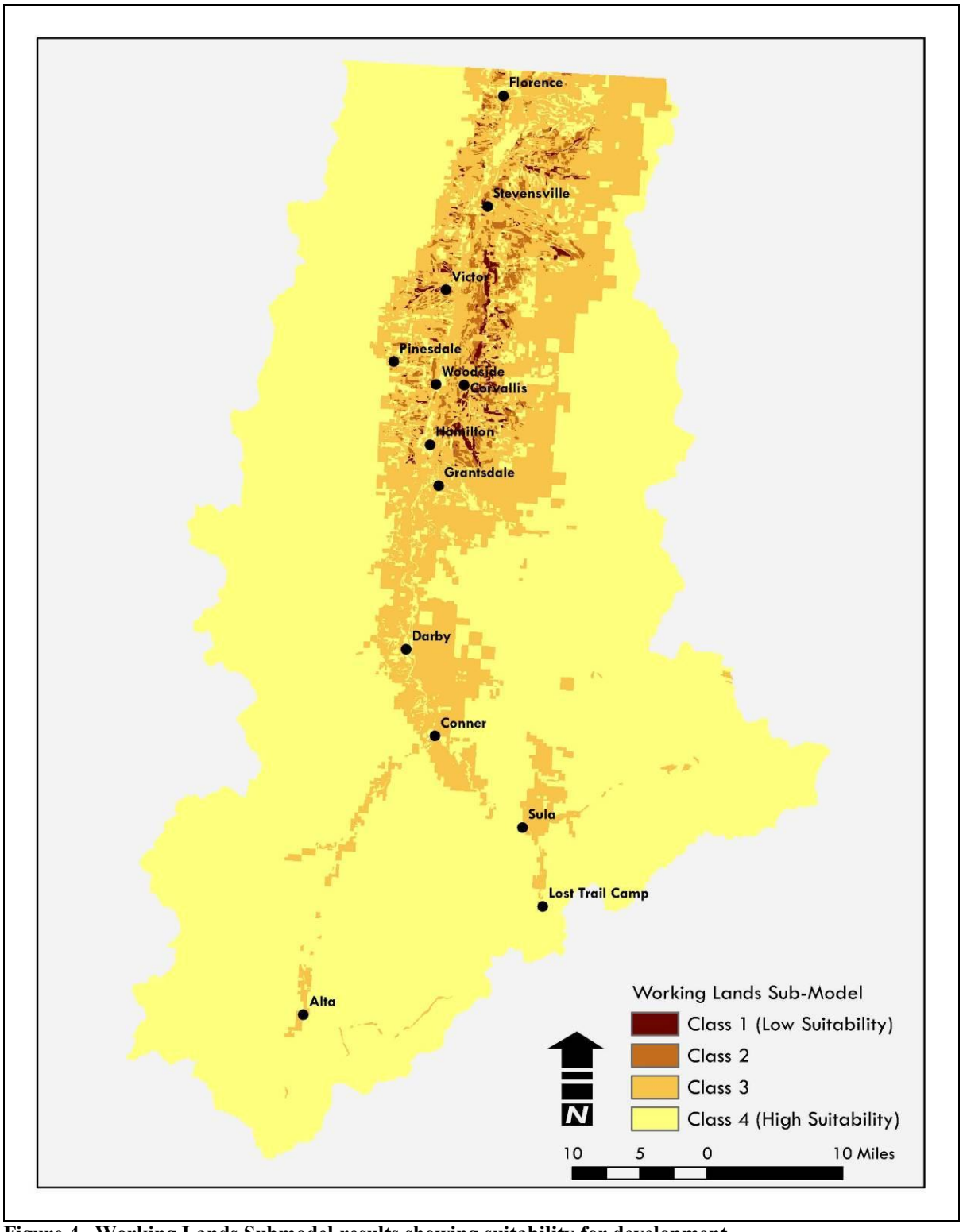


Figure 4. Working Lands Submodel results showing suitability for development.

3.4.2 Working Lands Submodel Criteria Rationale

There are four possible classes for the Working Lands Submodel ranging from least suitable for development (Class 1) to most suitable for development (Class 4) when considering working lands.

Class 1 (Least Suitable)
Class 1 identifies locations of existing working lands (includes farms, ranches, pasture, and timber production) that have both irrigation and prime farmland soils or farmland soils of statewide importance in Ravalli County. These areas are considered to be *least suitable for development* relative to working lands.

Class 2 (Less Suitable)
The second class (Class 2) identifies the locations of existing working lands that have both irrigation and locally important farmland soils. These areas are considered to be *less suitable for development* relative to working lands.

Class 3 (Moderately Suitable)
Class 3 identifies the locations of areas that are existing working lands (with or without any farmland soils classification or irrigation water); or areas with any farmland soils classification or irrigation water, where the land is not currently existing working land.

Class 4 (Most Suitable)
Class 4 is considered the *most suitable for development* when considering working lands, and includes all areas that are not Class 1, 2 or 3. The soil survey for the Bitterroot Valley Area, which includes data for farmland soils, is incomplete. As the soil survey is completed, additional areas may be included where prime if irrigated, farmland of statewide importance, or farmland of local importance soils are present.

3.4.3 Working Lands Submodel Criteria

Table 4 below shows the criteria used to evaluate each class described above for the Working Lands Submodel. Appendix D shows how data sets were used to develop the submodel, and data sets are described in more detail in Appendix A.

Table 4. Working Lands Resources Submodel criteria.

	Data Set [1]	Class 1: (*If **all** below are true*)	Class 2: (*If **all** below are true*)	Class 3: (*If **one** of A, B, or C is true*)	Class 4[3]: (*If **all** below are true*)
A	Cadastral[2]	('PROPTYPE' = 'agricultural rural' OR 'farmstead rural') OR ('CONT_CROP'>0) OR ('FALLOW_ACR'>0) OR ('GRAZING_AC'>0) OR ('TIMBER_ACR'>0) OR ('WILD_HAY_A'>0) OR ('IRRIG_ACRE'>0)	('PROPTYPE' = 'agricultural rural' OR 'farmstead rural') OR ('CONT_CROP'>0) OR ('FALLOW_ACR'>0) OR ('GRAZING_AC'>0) OR ('TIMBER_ACR'>0) OR ('WILD_HAY_A'>0) OR ('IRRIG_ACRE'>0)	('PROPTYPE' = 'agricultural rural', 'farmstead rural', or 'agricultural urban') OR ('CONT_CROP'>0) OR ('FALLOW_ACR'>0) OR ('GRAZING_AC'>0) OR ('TIMBER_ACR'>0) OR ('WILD_HAY_A'>0) OR ('IRRIG_ACRE'>0)	('PROPTYPE' not = 'agricultural rural', 'farmstead rural', or 'agricultural urban') OR ('CONT_CROP'=0) OR ('FALLOW_ACR'=0) OR ('GRAZING_AC'=0) OR ('TIMBER_ACR'=0) OR ('WILD_HAY_A'=0) OR ('IRRIG_ACRE'=0)
B	Soils	Farmland Classification = 'Prime Farmland' or 'Prime Farmland if Irrigated' or 'Statewide Important Soil'	Farmland Classification = 'Locally Important Soils'	Farmland Classification = 'Prime Farmland' or 'Prime Farmland if Irrigated' or 'Statewide Important Soil' or 'Locally Important Soils'	Farmland Classification not = 'Prime Farmland' or 'Prime Farmland if Irrigated' or 'Statewide Important Soil' or 'Locally Important Soils'
C	Irrigated lands (1958)	Present	Present	Present	Not Present

[1] Data sets are described in detail in Appendix A.
[2] This data set was used to find existing working lands and irrigated lands.
[3] Includes all areas that are not represented by the other three classes.

3.5 Open Lands Submodel

3.5.1 Open Lands Submodel Description

The Open Lands Submodel includes public lands, private lands protected with conservation easements, and large private parcels or contiguous parcels owned by the same person within Ravalli County. Criteria developed by the Open Lands Board are used to determine breaks among the different Open Lands Submodel classes. These criteria include parcel size and proximity to other protected lands. Table 5 provides a complete list of data sets used to develop this submodel. Figure 5 shows the results of the Open Lands Submodel.

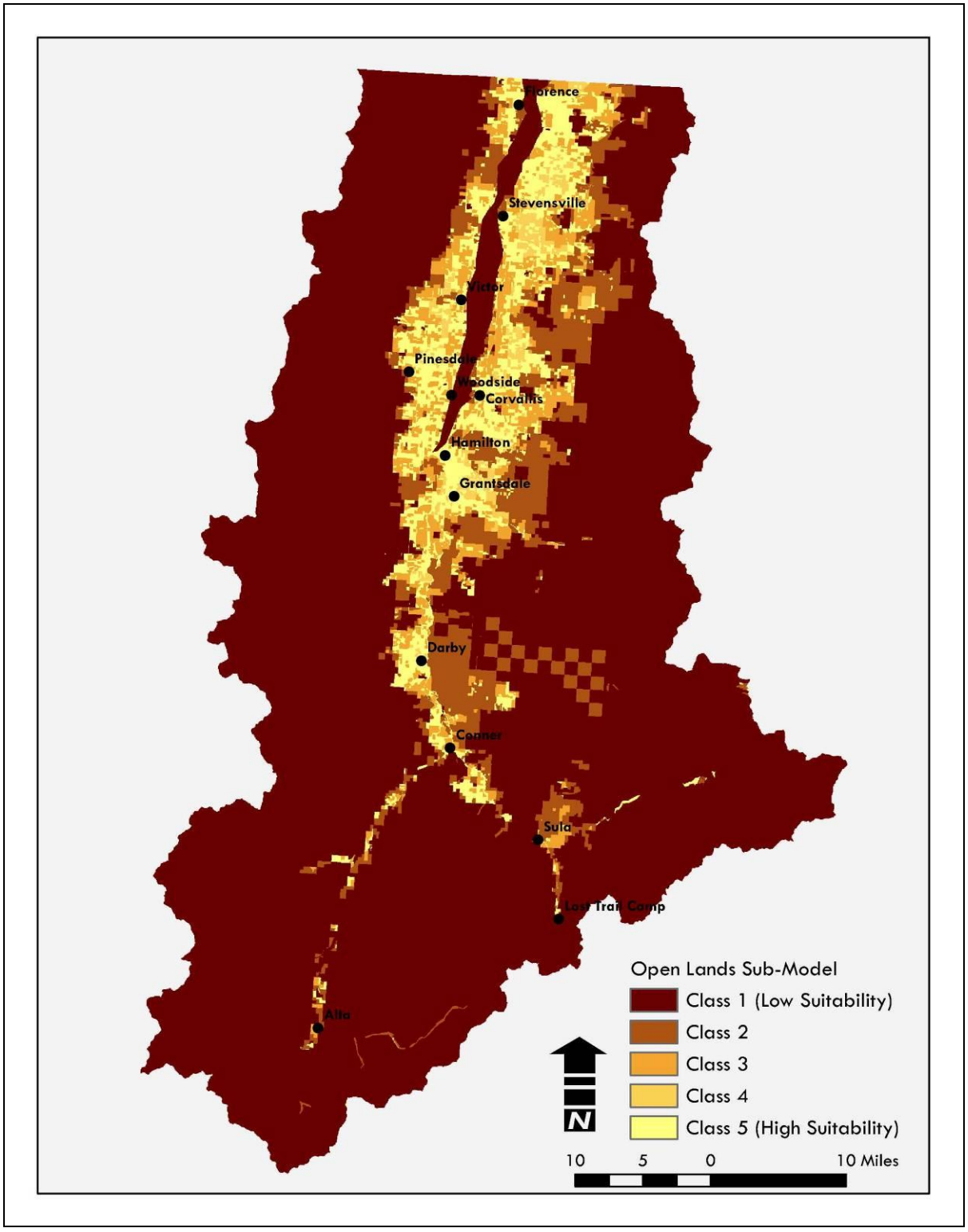


Figure 5. Open Lands Submodel results showing suitability for development.

3.5.2 Open Lands Submodel Criteria Rationale

There are five possible classes for the Open Lands Submodel, ranging from least suitable for development (Class 1) to most suitable for development (Class 5) considering open lands.

Class 1 (Least Suitable)
Class 1 identifies locations of existing open lands such as public lands, parks and private land that are protected from development by conservation easements. These lands are managed for conservation and where development is limited based on existing management plans and legal agreements.

Class 2 (Less Suitable)
Class 2 identifies individual parcels greater than 400 acres or contiguous parcels under the same ownership that total greater than 400 acres that would score higher in the open lands program. It also includes medium-sized parcels between 25 and 400 acres or contiguous parcels under the same ownership that total between 25 and 400 acres that are located immediately adjacent to existing open lands including public lands and private lands protected by conservation easements.

Class 3 (Moderately Suitable)
Class 3 identifies medium-sized individual parcels between 25 and 400 acres or contiguous parcels under the same ownership that total between 25 and 400 acres that would receive a moderate score based on the criteria in the open lands program. These lands have to be located within one mile of existing open lands (public land or private land protected by conservation easements) or immediately adjacent to working lands (between 25 and 400 acres in size).

Class 4 (More Suitable)
Class 4 includes medium-sized parcels between 25 and 400 acres or contiguous parcels under the same ownership that total between 25 and 400 acres that are more than one mile from existing open lands and not immediately adjacent to working lands.

Class 5 (Most Suitable)
Class 5 is considered the most suitable for development and represents all land that is not Classes 1, 2, 3, or 4.

3.5.3 Open Lands Submodel Criteria

Table 5 below shows the criteria used to evaluate each class described above for the Open Lands Submodel. Appendix D shows how data were combined to produce the submodel, and data sets are described in more detail in Appendix A.

Table 5. Open Lands Submodel criteria.

	Data Set [1]	**Class 1:** *(If **any** of A through C, or E below are true)*	**Class 2:** *(If F(1) below is true **OR** F(2) is true and any of A through E are true)*	**Class 3:** *(If F below is true **AND** any of A through E, or G are true)*	**Class 4:** *(If **all** below are true)*	**Class 5:** [2] *(If D below is true)*
A	Parks (Ravalli County)	Present	Immediately Adjacent	Within 1.0 Mile, but not immediately adjacent to	Not Within 1.0 Mile	NA
B	Stewardship Easements, Stewardship Owners, Stewardship Leases	Present	Immediately Adjacent	Within 1.0 Mile, but not immediately adjacent to	Not Within 1.0 Mile	NA
C	IBA	Present	Immediately Adjacent	Within 1.0 Mile, but not immediately adjacent to	Not Within 1.0 Mile	NA
D	Refuges	NA	Immediately Adjacent	Within 1.0 Mile, but not immediately adjacent to	Not Within 1.0 Mile	NA
E	Cadastral (Public Lands)	Ownclass = 'Local Government' OR 'State Government' OR 'US Department of Defense' OR 'US Government' OR 'USDA Forest Service' OR 'USDI Fish and Wildlife Service'	Immediately Adjacent to (Ownclass = 'Local Government' OR 'State Government' OR 'US Department of Defense' OR 'US Government' OR 'USDA Forest Service' OR 'USDI Fish and Wildlife Service')	Within 1.0 Mile of (Ownclass = 'Local Government' OR 'State Government' OR 'US Department of Defense' OR 'US Government' OR 'USDA Forest Service' OR 'USDI Fish and Wildlife Service')	Not Within 1.0 Mile of (Ownclass = 'Local Government' OR 'State Government' OR 'US Department of Defense' OR 'US Government' OR 'USDA Forest Service' OR 'USDI Fish and Wildlife Service')	NA
F	Cadastral (Parcel Size)	NA	1. [(Parcel Size > 400 acres) OR (Contiguous parcels owned by same owner total > 400 acres)] **OR** 2. [(Parcel Size >= 25 and <= 400 acres) OR (Contiguous parcels owned by the same owner total >= 25 and <= 400)]	(Parcel Size >= 25 and <= 400 acres) OR (Contiguous parcels owned by the same owner total >= 25 and <= 400)	(Parcel Size >= 25 and <= 400 acres) OR (Contiguous parcels owned by the same owner total >= 25 and <= 400)	(Parcel Size < 25) OR (Contiguous parcels owned by the same owner total < 25)
G	Cadastral (Working Lands)	NA	NA	Immediately Adjacent to {[('PROPTYPE' = 'agricultural rural' OR 'farmstead rural') OR ('CONT_CROP'>0) OR ('FALLOW_ACR'>0) OR ('GRAZING_AC'>0) OR ('TIMBER_ACR'>0) OR ('WILD_HAY_A'>0)] AND [(Parcel Size >= 25 and <= 400 acres) OR (Contiguous parcels owned by the same owner >= 25 and <= 400)]}	Not Immediately Adjacent to {[('PROPTYPE' = 'agricultural rural' OR 'farmstead rural') OR ('CONT_CROP'>0) OR ('FALLOW_ACR'>0) OR ('GRAZING_AC'>0) OR ('TIMBER_ACR'>0) OR ('WILD_HAY_A'>0)] AND [(Parcel Size >= 25 and <= 400 acres) OR (Contiguous parcels owned by the same owner >= 25 and <= 400)]}	NA

[1] Data sets are described in detail in Appendix A.

[2] Includes all areas that are not represented by the other four categories.

3.6 Public Health and Safety Submodel

3.6.1 Public Health and Safety Submodel Description

This submodel identifies five components of the biophysical environment of Ravalli County that affect the health and safety of the public. Based on available data, advice from local experts, the goals in the Ravalli County Growth Policy, and guidance from State Law and the Ravalli County Subdivision Regulations, it was determined that wildfire hazard, slope, septic suitability of soils, and FEMA and dam breach floodplain locations are the most likely issues that could preclude safe development in the County. Each of these components was developed with the guidance of local experts. The tables below outline the criteria used to classify the various inputs of the Public Health and Safety Submodel. The class number corresponds to the mathematical value given to the respective pixels in each dataset. See Appendix A for details about the source of each dataset. Figure 6 shows the result of the Public Health and Safety Submodel.

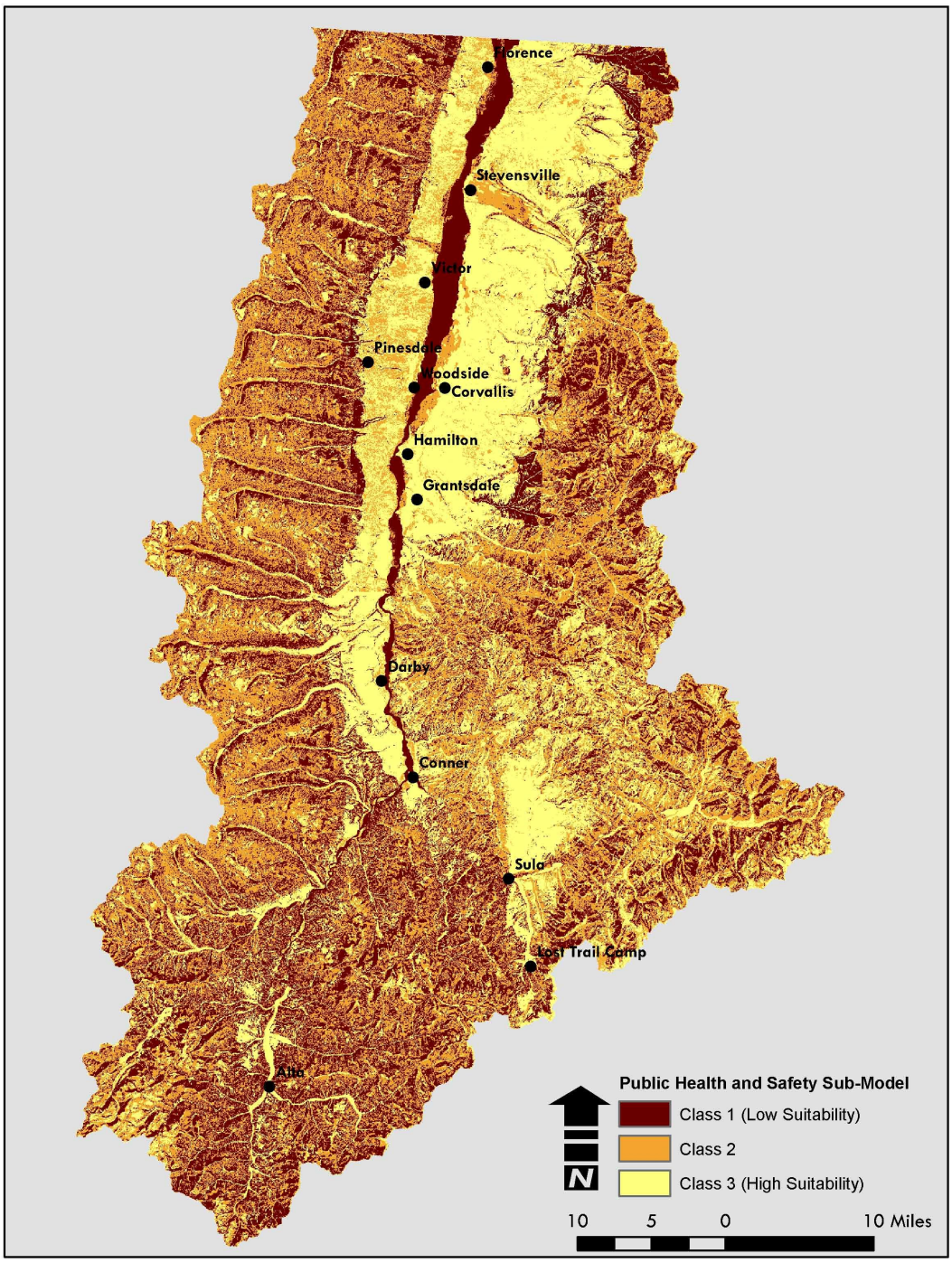


Figure 6. Public Health and Safety Submodel results showing suitability for development.

3.6.2 Public Health and Safety Submodel Criteria Rationale

As indicated previously, the Public Health and Safety submodel is comprised of five different health and safety components. Following are detailed rationales for each component, as well as tables indicating the classification scheme for each.

Wildfire Hazard

For the purposes of the public health and safety submodel, wildfire hazard is defined as the likelihood of a fire that is beyond the control of direct, on-the-ground firefighting efforts. When the energy being released by a fire is such that direct control measures are impossible, firefighters are forced to use indirect methods to fight the fire. In such a situation, the fire has a high likelihood of becoming a large, fast-moving incident, placing life and property at much greater risk. The fire hazard model is designed to find those areas within Ravalli County that are at risk of exceeding the control threshold during a fire event.

The fire hazard model is based on a Forest Service product known as the Fire Behavior Assessment Tool, or FBAT. FBAT runs within ArcMap and incorporates a variety of spatial data inputs relevant to fire behavior, including vegetation, topography and wind speed. When estimating the behavior of a hypothetical fire, fire managers frequently refer to an FBAT output called fire line intensity. Fire line intensity attempts to quantify the amount of energy being released by an advancing fire as it moves across the ground. It is measured as kilowatts of energy per meter of ground distance per second.
The Forest Service has established three classes of fire line intensity (Jones, pers. comm., 2007). Using this guidance, the output was classified such that all areas less than 328 kW/m/s were interpreted as having a low fire hazard and were assigned a 'most suitable' development rating. Areas having a fire line intensity between 328 and 3,280 kW/m/s are considered as having moderate fire hazard and were given a 'moderately suitable' rating. A fire line intensity above 3,280 kW/m/s is considered to represent dangerous fire behavior, and a 'least suitable' rating was assigned to these areas. According to researchers, a fire releasing energy at a rate greater than 3,280 kW/m/s is beyond the direct control of firefighters. This is the threshold above which human life and property are at much greater risk. Table 6 illustrates the classification criteria. **Note**: For all of the following tables (6 through 10), the class numbers equal the values assigned to the respective pixels in the raster dataset. For example, all pixels satisfying the Class 2 criteria are assigned a value of 2.

Table 6. Fire Hazard classification criteria.

	Class 1: *Low Development Suitability*	**Class 2:** *Moderate Development Suitability*	**Class 3:** *High Development Suitability*
Fire Hazard (energy release)	>3,280 kW/m/s	328 to 3,280 kW/m/s	<328 kW/m/s

Slope

The Ravalli County Subdivision Regulations stipulate that no development may occur on slopes greater than 25%, unless there are mitigating circumstances (Ravalli Planning

Department, pers. comm., 2007). For the public health and safety submodel, the USGS 30-meter digital elevation model was analyzed for percent slope. All pixels with greater than 25% are classified as 'least suitable,' and all other areas are 'most suitable.'

Table 7. Slope hazard classification criteria.

	Class 1: *Low Development Suitability*	**Class 3:** *High Development Suitability*
Slope	>25%	<25%

Floodplain (FEMA)

The FEMA 100- and 500-year floodplain boundaries were designated by the Ravalli County Floodplain Coordinator as being unsuitable for development. Areas outside the floodplain are considered highly suitable.

Table 8. Floodplain hazard classification criteria.

	Class 1: *Low Development Suitability*	**Class 3:** *High Development Suitability*
Floodplain	Within 100- or 500-yr FEMA floodplain areas	Outside of floodplain

Dam Breach Floodplain (DNRC)

Included in the Public Health and Safety submodel is the delineation of the Ravalli County dam failure floodplain. This layer estimates the extent of the valley that might be inundated by an upstream dam breach (MDNRC, 2004). Since a dam failure flood is much less likely to occur than a natural flood, the layer is given a value of 'moderately suitable' for development instead of 'least suitable' so as to reduce its effect on the entire submodel.

Table 9. Dam breach floodplain hazard classification criteria.

	Class 2: *Moderate Development Suitability*	**Class 3:** *High Development Suitability*
Dam Breach Floodplain	Within dam breach floodplain area	Outside of dam breach floodplain area

Septic Suitability (NRCS)

The septic suitability of any given soil type depends on a variety of properties relating to texture, drainage and depth to groundwater (Montana NRCS, pers. comm., 2007). The Natural Resources Conservation Service (NRCS) compiles such information in Soil Survey Geographic (SSURGO) databases. A SSURGO for Ravalli County has been completed for the area north of Hamilton. The NRCS has created a GIS-based tool called the Soil Data Viewer (SDV) to assist with querying the SSURGO database and to facilitate map creation. The SDV contains a septic suitability query that is specifically designed to guide the siting of septic tank facilities. While running this query, the SDV evaluates all of the soil mapping units for septic suitability and assigns each one a

limitation rating. Following is a description of the ratings as given by the SDV documentation:

> Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

In the public health and safety submodel, areas rated "not limited" in the SSURGO were given a development suitability value of 'most suitable.' Areas rated "somewhat limited" were given a value of 'moderately suitable,' and areas rated "very limited" were assigned a value of 'least suitable.'

Based on the recommendation of the NRCS, a conservative valuation of "somewhat limited" was applied to all areas in Ravalli County that are not covered by the SSURGO. In the public health and safety submodel this translates to the 'moderately suitable' class. These classifications can be reevaluated when the SSURGO has been completed for the entire county.

Table 10. Septic limitation classification criteria.

	Class 1: *Low Development Suitability*	**Class 2:** *Moderate Development Suitability*	**Class 3:** *High Development Suitability*
Septic Limitations (taken from NRCS soils classifications)	Very limited soils	Somewhat limited soils	Not limited soils

3.6.3 Public Health and Safety Submodel Criteria

For this submodel, an estimation of the *cumulative* effect of the five health and safety components was desired. Therefore, a Boolean approach to submodel design was not used. Instead, each of the five components was classified individually and the results were *added* together. The result was divided into three development suitability classes using natural breaks.

Class 1 (Low Suitability)

Class 1 areas have a total public health and safety score of 6 to 11. These areas are characterized by a combination of high wildfire hazard, slopes >25%, 100- or 500-year floodplain and/or extremely limiting soils for septic development.

Class 2 (Moderate Suitability)
Class 2 areas have a total public health and safety score of 11 to 12. These areas are characterized by a combination of moderate wildfire hazard, dam breach floodplain and/or moderately limiting soils for septic development.

Class 3 (High Suitability)
Class 3 areas have a total public health and safety score of 12 to 15. These areas are characterized by a combination of little to no wildfire hazard, slopes <25%, no floodplain present and/or soils that are not limited for septic development.

Classes 1, 2 and 3 were reclassified to the values 1, 7 and 13 respectively before the dataset was combined with the other five LSA submodels (see Table 11).

3.7 The Land Suitability Analysis (Combining Six Submodels into One Final Model)

3.7.1 Reclassifying Submodels

The number of original suitability classes in each submodel is dictated by the resolution of the input data layers and the criteria used to combine them. The Existing Infrastructure, Public Health and Safety, and Water Resources submodels each have three classes. The Working Lands and Wildlife submodels each contain four classes of suitability, while the Open Lands Submodel has five. To avoid mathematical biasing, all of the submodels were standardized to the same value scale before they were combined. Given the unequal numbers of classes of the submodels, it was determined that a scale of 1 to 13 would work best for all of them. Each dataset was 'stretched' from 1 to 13, with equal spacing between the values. Table 11 illustrates the conversion between the original classification and composite reclassification of each submodel.

Table 11. Submodel reclassification scheme.

Submodel	Original Suitability Classification	Composite Suitability Reclassification
Public Health and Safety	1	1
	2	7
	3	13
Existing Infrastructure	1	1
	2	7
	3	13
Open Lands	1	1
	2	4
	3	7
	4	10
	5	13
Wildlife	1	1
	2	5
	3	9
	4	13
Working Lands	1	1
	2	5
	3	9
	4	13
Water Resources	1	1
	2	7
	3	13

3.7.2 Combining Submodels

The submodels were added together using the Map Algebra feature in ArcGIS Spatial Analyst. Since each submodel contributes equally to the suitability model, no weighting was used. The final suitability value for any given pixel is simply the additive sum of all the submodel results for that pixel. The values are integers ranging from 6 to 74, with 6 being the least suitable score and 74 being the most suitable for development. When a 3-class natural breaks classification is applied to the final grid, the value ranges are 6-32 (low suitability), 33-44 (moderate suitability) and 45-74 (high suitability). When a 5-class natural breaks classification is applied, the value ranges are 6-26, 26-36, 36-44, 44-51 and 51-74. Figure 7 shows the results of the final model, displayed with 5 natural breaks classes.

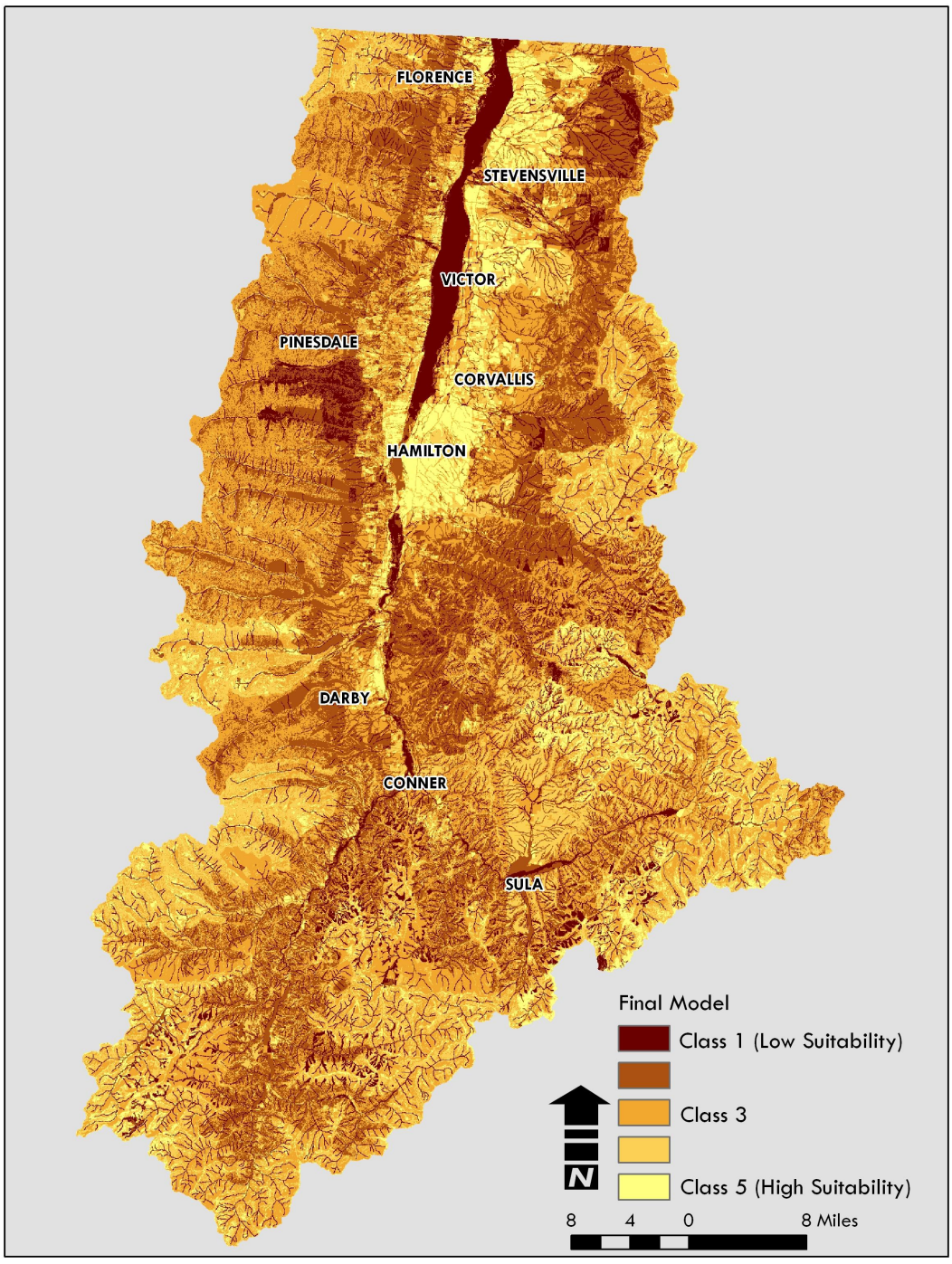


Figure 7. Final Land Suitability Analysis results.

4.0 Use and Recommendations

4.1 The Land Suitability Analysis

The results of the LSA provide a map showing the relative suitability of land for development at a coarse scale. *This map is not a zoning map and it is **not** intended to be used for site-specific planning.*

4.2 Use in the Countywide Zoning Project

Prior to the release of the results of the Land Suitability Analysis, the Planning Department visited each Community Planning Committee to present basic GIS concepts and the approach used to create the Land Suitability Analysis. The results of the Land Suitability Analysis were then presented to the public at a workshop on January 26, 2008. Maps showing the results of each of the six submodels, as well as the final model, at a countywide scale were displayed. Each Community Planning Committee was given a set of seven maps (the results of each of the six submodels and the final model) clipped to the extent of the school district. These map sets were available as the Community Planning Committees were drafting value maps to guide the planning consultant in drafting zoning maps. The planning consultant was also given the grids for each of the six submodels and the final model. The Planning Board and the Board of County Commissioners will be given countywide map sets and the report.

4.3 Recommendations

The Planning Department will store the data sets used in the Land Suitability Analysis and the report so the analysis can be updated in the future. The Ravalli County Environmental Health Department is currently working on a Groundwater Vulnerability Analysis. The Planning Department is working with the Environmental Health Department to ensure that the results of the Groundwater Vulnerability Analysis can be incorporated into the Land Suitability Analysis.

Several important factors are missing from the Land Suitability Analysis because there is no existing data. Groundwater supply and air quality were identified as high priority data sets.

4.4 GIS Data

All of the GIS datasets used in the creation of the LSA are available on a DVD. Each submodel raster, as well as the final suitability model raster, is located in a geodatabase. Each is accompanied by metadata viewable in ArcCatalog.

Also included on the data disc are the original vector datasets used in the model (see Appendix D for detailed descriptions of some of these datasets), as well as intermediate geoprocessing rasters. A copy of the ArcToolbox file (.tbx) created for the LSA is included. The toolbox contains the ModelBuilder schematics used to geoprocess the LSA. Exploring these schematics in ArcCatalog will reveal the methodology used to create the model. Please see the 'readme.txt' file on the data DVD for instructions.

5.0 References

Bitterroot Resource Conservation & Development Area (BRRCD), Inc., USDA Forest Service, Montana DNRC. 2003. Bitterroot Valley Community Wildfire Protection Plan.

City of Hamilton, Montana. FY 2004-2008. City of Hamilton Growth Policy. Prepared by the City of Hamilton Planning Board January to August, 2003. Adopted by the Hamilton City Council in September, 2003.

DeHaan, Roger. 2007. Personal communication with Roger DeHaan, consulting engineer for the Corvallis and Victor Sewer Districts in December, 2007.

HDR, Inc. 2006. City of Hamilton Wastewater Facility Plan.

Hendrix, Laura. 2007. Personal communication with Laura Hendrix, Ravalli County Floodplain Administrator, September, 2007.

Intermountain West Joint Venture, Montana Steering Committee. 2005. Coordinated Implementation Plan for Bird Conservation in Western Montana.

Jones, Jeff. 2007. Personal communication with Jeff Jones, United States Forest Service, December, 2007.

Land and Water Consulting, 2004. Ravalli County Pre-Disaster Mitigation Plan.

Land Use Clinic. 2007. Highway 93S Corridor: Supporting Document for Proposed Wildlife Crossing Overlay District. Prepared for Ravalli County Planning Department. May 9, 2007.

Lear, Alan. 2007. Personal communication with Alan Lear, Field Engineer for the Ravalli Electric Cooperative in December, 2007.

Lonn, Jeffrey D. and Sears, James W. 2001. Surficial Geologic Map of the Bitterroot Valley, Montana. Montana Bureau of Mines and Geology, Open File Report 441a, 441b, and 441c.

Merkel, Justin. 2007. Personal communication with Justin Merkel, Hamilton Operations Supervisor for NorthWestern Energy in December, 2007.

Montana Department of Environmental Quality, Water Quality Planning Bureau. 2006. 2006 Integrated 303(d)/305(b) Water Quality Report for Montana.

Montana Department of Natural Resources Conservation, Water Projects Bureau. 2004. Emergency Action Plans for dams in Ravalli County.

Montana Fish, Wildlife and Parks. 2005. Montana's Comprehensive Fish and Wildlife Conservation Strategy.

Montana Natural Resources Conservation Service. 2007. Personal communication with soil scientists, December, 2007.

Professional Consultants, Incorporated. 2006. Town of Stevensville Street Master Plan.

Professional Consultants, Incorporated. 2003. Town of Stevensville Water & Sewer Master Plan.

Ravalli County, Montana. 2003. Ravalli County Airport Influence Area Regulations and Airport Layout Plan.

Ravalli County, Montana. 2006. Old Corvallis Road Area 3 Neighborhood Plan, Ravalli County Growth Policy Amendment.

Ravalli County, Montana. 2002. Ravalli County Growth Policy. Prepared by citizens of Ravalli County August 29, 2001 through December 5, 2002. Recommended for adoption and implementation by the Ravalli County Planning Board, December 11, 2002. Adopted by the Board of County Commissioners, December 31, 2002. Amended by the Board of County Commissioners, April 7, 2003 and August 18, 2004.

Ravalli County Open Lands Bond Program. 2007. Project Scoring Worksheet. Open Lands Guideline and Procedure Documents, adopted by the BCC on November 5, 2007. Available at: (http://www.ravallicounty.mt.gov/planning/OpenLandsBoard.htm).

Ravalli County Planning Department. 2007. Personal communication with Ravalli County planners, November, 2007.

Scheele, Rick. 2007. Personal communication with Rick Scheele, Mayor of the Town of Darby in December, 2007.

Stranger, Dennis. 2007. Personal communication with Dennis Stranger, City of Hamilton Planner, December, 2007.

Swanson, Larry. 2006. Growth and Change in the Bitterroot Valley and Implications for Area Agriculture and Ag Lands. Prepared for the Ravalli County Right to Farm and Ranch Board and Bitter Root Land Trust by O'Connor Center for the Rocky Mountain West, University of Montana, Missoula, MT. 64 p.

Town of Stevensville. 2002. Town of Stevensville Comprehensive Plan.

Town of Stevensville. 2007. Town of Stevensville Code Book.

Town of Stevensville. 2001. Zoning Ordinance to Limit Height of Objects and Land Use Around the Stevensville Airport.

Weidow, Rocky. 2007. Personal communication with Rocky Weidow, Chairman of the Selectmen for the Town of Pinesdale in December, 2007.

Appendix A – Data Descriptions

Data sets used for each submodel are summarized below.

I. Existing Infrastructure Submodel

City of Hamilton 20-Year Planning Area – (City of Hamilton)

The *City of Hamilton FY 2004-2008 Growth Policy* includes a map of the 20-year planning area. The City contracted HDR, Inc. for mapping work. Ravalli County obtained digital data of the 20-year planning area from HDR, Inc. Dennis Stranger, City of Hamilton Planner, recommended that this boundary be rated for high suitability because it is in the Growth Policy and is the best available data.

Stevensville Planned Growth Area – (Town of Stevensville)

The *Town of Stevensville Street Master Plan, 2006* includes a map of the Planned Growth Area. The plan states: "The Town of Stevensville Public Works contracted Professional Consultants to develop a Street Master Plan for the Town and the defined Planned Growth Area." There is no explanation as to how the Planned Growth Area was developed, but it appears to be the best available data. Digital data of the Planned Growth Area was obtained from Professional Consultants, Inc, contract engineer for the Town of Stevensville.

Incorporated Areas – (Ravalli County GIS Department)

The Ravalli County GIS Department maintains incorporated areas in a GIS format. The incorporated areas (region.law) can be found within a coverage titled "esz".

Sewer Districts – (Ravalli County GIS Department)

The Ravalli County GIS Department maintains sewer districts in a GIS format. The sewer districts are in sewer_water.shp. The "NAME" field can be queried to determine the name of the sewer district.

II. Water Resources Submodel

National Hydrography Dataset – Flow Line – (USGS and USEPA)

These data and metadata were developed primarily by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) and are available online at (http://nhd.usgs.gov/index.html). These data show naturally occurring and constructed water bodies, as well as paths that convey water and related entities. The field 'FType' in the attribute table contains the following values: 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', and 'Artificial Path'. The dataset defines streams and rivers as "(a) body of flowing water" and canals and ditches as "(a)n artificial open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft.

The dataset also includes the 'hydrographic category' in the attribute table field 'FCode' that "describes the portion of the year the feature contains water" with values of 'intermittent' and 'perennial' defined as follows:

- Intermittent – "Contains water for only part of the year, but more than just after rainstorms and at snowmelt"

- Perennial – "Contains water throughout the year, except for infrequent periods of severe drought"

National Hydrography Dataset – Area – (USGS and USEPA)
These data and metadata were developed primarily by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) and are available online at (http://nhd.usgs.gov/index.html). These data show naturally occurring and constructed water bodies, as well as paths that convey water and related entities. The field 'FType' in the attribute table includes a value of 'StreamRiver' that shows polygon data for streams and river features. Other values are also present in this field but this is the most common and relevant value for Ravalli County.

National Hydrography Dataset – Waterbody – (USGS and USEPA)
These data and metadata were developed primarily by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA) and are available online at (http://nhd.usgs.gov/index.html). These data show naturally occurring and constructed water bodies, as well as paths that convey water and related entities. The field 'FType' in the attribute table includes the following values: 'LakePond', 'Reservoir', and 'SwampMarsh'. The dataset defines lakes and ponds as "(a) standing body of water with a predominantly natural shoreline surrounded by land."

2007 Wetlands – (USFWS, National Wetlands Inventory)
These data and metadata were developed by the U.S. Fish and Wildlife Service, National Wetlands Inventory and are available online at (http://www.fws.gov/nwi). These data show wetlands and deep water habitats for several USGS 1:24,000 quadrangles and the Hamilton 1:100,000 USGS quadrangle in Ravalli County. The field 'ATTRIBUTE' includes codes describing the type of wetland according to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

2005 Pilot Wetlands Mapping Project – (Bitterroot Water Forum)
These data and metadata were developed by the Bitterroot Water Forum to show wetlands in a ten-mile square area of the northern portion of Ravalli County. The field 'Wetland_Ty' includes codes describing the type of wetland according to *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

U.S. Forest Service Wetlands – (USFS)
These data were developed by the United States Forest Service and show wetland features on Forest Service lands.

Riparian – (MNHP)
These data were developed by the Montana Natural Heritage Program. These data show riparian plant communities in the Bitterroot Valley and were created using National Wetlands Inventory standards. Riparian polygons were digitized over 2005 color infrared aerial photographs. The following data sets were also used for interpretation; Ssurgo soils data, scanned and referenced 1980's color infrared aerial photographs, 10 meter digital elevation model, NRCS soil sample points, and 2004 natural color aerial

photographs. The field 'HGM_CODE' includes Hydrogeomorphic codes for the riparian plant community type in each polygon modified from *Wetland Indicators, A Guide to Wetland Identification, Delineation, Classification and Mapping* (Tiner 1999).

Floodplain – (FEMA)
These data were developed by the Ravalli County GIS Department by digitizing paper floodplain maps created by the Federal Emergency Management Agency. These data show the 100-year flood fringe (hazard), 100-year floodway and the 500-year flood hazard of the Bitterroot River. The floodplain is defined as "any area susceptible to inundation by water from any source" and a floodway is defined as "the channel of a river and the adjacent overbank areas reserved to carry base flood discharge without raising the BFE more than a designated amount" (http://training.fema.gov/EMIWeb/IS/IS394A/glossary-0306.doc).
For the public health and safety submodel, both floodplains were combined and all islands included (Hendrix, pers. comm., 2007). All pixels falling within this area are considered 'least suitable' for development, while all areas outside it are considered 'most suitable.'

Bitterroot Valley Area, Montana Soil Survey – (USDA NRCS)
These data and metadata were developed by the U.S. Department of Agriculture, Natural Resources Conservation Services. These data show soil map units delineated in the Bitterroot Valley. The survey is complete through much of the northern portion of Ravalli County above Hamilton, with some incomplete areas primarily on the east side of the valley.

The hydric soils list (http://soils.usda.gov/use/hydric/lists/state.html) includes soil map units that have hydric components. Hydric soils are soils that formed under anaerobic conditions, such as those found in wetlands. The hydric soils list, or a sub-set of the list, may be useful for identifying soil map units associated with wetland features. For this analysis, hydric soils were included where the column 'representative percent composition' was greater than 50 percent. Some soil map units may have a high percentage of components that are considered hydric and others may have a lower percentage of hydric components.

Irrigation Ditches – (State Engineer's Office)
These data are based on the 1958 Water Resources Survey for Ravalli County, Montana published by the State Engineer's Office. The data set was created by scanning and digitizing the ditches shown in maps from this document into a GIS environment. The data show the 1958 locations of irrigation ditches throughout Ravalli County.

Subwatershed (6^{th}-code) Hydrologic Units – (NRCS)
These data and metadata were developed the U.S. Department of Agriculture, Natural Resources Conservation Service.

TMDL Streams and Lakes – (MTDEQ)
These data and metadata were developed by the Montana Department of Environmental Quality and are available online at (http://www.deq.state.mt.us/CWAIC/wq_reps.aspx?yr=2006qryId=0). The dataset is based on the 2006 Integrated 305(b) / 303(d) Water Quality Report. An associated table 'WQS_Attainments' in the database 'Final_MT_2006_ADB' has a field 'Attainment' with the following values:

- F = Fully supporting
- I = Insufficient information
- N = Not supporting
- X = Not assessed

III. Wildlife Resources Submodel

National Hydrography Dataset – Flow Line – (USGS and USEPA) (See Water Resources Submodel)

National Hydrography Dataset – Area – (USGS and USEPA) (See Water Resources Submodel)

National Hydrography Dataset – Waterbody – (USGS and USEPA) (See Water Resources Submodel)

Riparian – (MNHP) (See Water Resources Submodel)

2007 Wetlands – (USFWS, National Wetlands Inventory) (See Water Resources Submodel)

2005 Pilot Wetlands Mapping Project – (Bitterroot Water Forum) (See Water Resources Submodel)

U.S. Forest Service Wetlands – (USFS) (See Water Resources Submodel)

Bitterroot Important Bird Area – (Montana Audubon Society)
These data were developed by the Montana Audubon Society to show the extents of an *Important Bird Area* delineated in the Bitterroot River floodplain in Ravalli County. The National Audubon Society describes the Important Bird Areas Program as "…a global effort to identify and conserve areas that are vital to birds and other biodiversity." The National Audubon Society describes Important Bird Areas as sites that provide essential habitat (breeding, wintering, and/or migration) for one or more species of bird. An Important Bird Area "…must satisfy at least one of the following criteria. The site must support:

- Species of conservation concern (e.g. threatened or endangered species)
- Restricted-ranges species (species vulnerable because they are not widely distributed)

- Species that are vulnerable because their populations are concentrated in one general habitat type or biome
- Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their congregatory behavior"

Blodgett Important Bird Area – (Montana Audubon Society)
These data were developed by the Montana Audubon Society to show the extents of an *Important Bird Area* delineated in the Blodgett Canyon burned area in Ravalli County. The National Audubon Society describes the Important Bird Areas Program as "…a global effort to identify and conserve areas that are vital to birds and other biodiversity." The National Audubon Society describes Important Bird Areas as sites that provide essential habitat (breeding, wintering, and/or migration) for one or more species of bird. An Important Bird Area "…must satisfy at least one of the following criteria. The site must support:

- Species of conservation concern (e.g. threatened or endangered species)
- Restricted-ranges species (species vulnerable because they are not widely distributed)
- Species that are vulnerable because their populations are concentrated in one general habitat type or biome
- Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their congregatory behavior"

National Wildlife Refuges – (Montana Natural Heritage Program)
These data were developed by the Montana Natural Heritage Program and are available online at (http://www.nris.mt.gov/gis) and directly from the Montana Natural Heritage Program. These data were developed using statewide land ownership and managed areas layer that is maintained by the Montana Natural Heritage Program. Boundaries of National Wildlife Refuges are shown and the Refuge name is included in attribute data.

Bighorn Sheep Overall Distribution and Winter Range – (MTFWP)
These data and metadata were developed by Montana Fish Wildlife and Parks and are available online at (http://fwp.mt.gov/insidefwp/GIS/). The data were reviewed and updated in 2002. These data show overall distribution or year round range as well as winter range which are areas occupied between November 15 and March 1 each year. Polygons may have more than one use of either overall distribution (spring, summer and fall use) or winter range. The 'BHS_USE' field in the attribute table has values of 'G' for overall distribution and 'W' for winter range. However, some polygons have a value of 'GW' for both overall distribution and winter range. These polygons will be treated as winter range for the purposes of evaluating the data set for the wildlife resources submodel.

Mule Deer Distribution – (MTFWP)
These data and metadata were developed by Montana Fish Wildlife and Parks and are available online at (http://fwp.mt.gov/insidefwp/GIS/). These data show mule deer

habitat and seasonal distribution. The field 'LIMIT' in the attribute table includes codes and descriptions of limiting factors for mule deer populations including the following:

- 0 – Domestic livestock forage competition
- 1 – Habitat succession/maturation
- 2 – Urban expansion
- 5 – Riparian impacts/habitat over utilization
- 6 – Timber harvest impacts
- 10 – Habitat conversion (plowing, burning, etc)
- 17 – Competition with other wild ungulates
- 18 – Special situations (tribal lands, national parks)

The field 'CLASS' in the attribute table includes codes and descriptions of mule deer habitat classifications including the following:

- B – "Spring, Summer, Fall Range. That part of the overall range where 90% of the individuals are located between spring green-up and the first heavy snowfall. Summer range is not necessarily exclusive of winter range; in some areas winter range and summer range may overlap."
- D – "Winter range. That portion of the overall range where 90% of the individuals are located during the average five winters out of ten from the first heavy snowfall to spring green-up, or during a site-specific period of winter."
- F – "An area that provides year-round range for a non-migratory population of mule deer. The resident deer use all of the area all year."
- BD – "Winter/Yearlong Range"
- FD – "Winter/Yearlong Range"

Moose Distribution – (MTFWP)

These data and metadata were developed by Montana Fish Wildlife and Parks and are available online at (http://fwp.mt.gov/insidefwp/GIS/). These data show overall moose distribution and winter range. Winter range includes areas that are generally occupied between November 15 and March 1 each year. The field 'USE' in the attribute table includes codes and titles for use of the polygons by moose including:

- G – Overall Distribution
- GW – Overall Distribution and Winter Range
- Z – Non- use
- T – Transitional Area

Mountain Goat Distribution – (MTFWP)

These data and metadata were developed by Montana Fish Wildlife and Parks and are available online at (http://fwp.mt.gov/insidefwp/GIS/). These data indicate overall distribution and winter range for mountain goats. Winter range includes areas occupied between November 15 and March 1 each year. The field 'USE' in the attribute table has a value of 'G' for areas occupied throughout the year and a value of 'GW' for areas occupied throughout the year including winter (winter range).

Elk Distribution – (MTFWP)
These data and metadata were developed by Montana Fish Wildlife and Parks and are available online at (http://fwp.mt.gov/insidefwp/GIS/). These data show elk winter range, crucial winter range, summer range, crucial summer range, calving areas and migration areas. Several fields in the attribute table are used to show the different types of elk range summarized below:

- WINHAB – Y indicates winter range
- WCRUCIAL – C indicates crucial winter range
- WLF_ID – includes codes for limiting factors for winter range
- SUMMHAB – Y indicates summer range
- SCRUCIAL – C indicates crucial summer range
- SLF_ID – includes codes for limiting factors for summer range
- PARTUHAB – Y indicates calving areas
- PCRUCIAL – C indicated crucial calving areas
- PLF_ID – includes codes of limiting factors for calving range
- MIGRATHAB – Y indicated migration areas
- MLF_ID – includes code of limiting factors for migration areas

Subwatershed (6^{th}-code) Hydrologic Units – (NRCS) (See Water Resources Submodel)

Bull Trout – Critical Habitat (streams) (USFWS)
These data and metadata were developed by the U.S. Fish and Wildlife Service and are available online at (http://www.fws.gov/pacific/bulltrout/). These data show the general location and extent of critical habitat for bull trout according to the final rule published in the Federal Register on September 26, 2005. The final rule includes legal descriptions of critical habitat and this layer is to be used a guide to interpret these locations. A sub-set of these data were used in the analysis based on information from Montana Fish Wildlife and Parks fish biologists.

Floodplain – (FEMA) (See Water Resources Submodel)

IV. Working Lands Submodel

Ravalli County Parcel Data – (Montana Cadastral Mapping Project)
These data and metadata were developed by the Montana Cadastral Mapping Project and are available online at (http://gis.doa.mt.gov/). Some of the data included in the attribute table for this data set includes the following:

- The type of property for tax purposes such as 'farmstead rural', 'agricultural rural', and others
- The type of ownership such as 'private', 'local government', and others
- The number of irrigated acres

Bitterroot Valley Area, Montana Soil Survey – (USDA NRCS)
These data and metadata were developed by the U.S. Department of Agriculture, Natural Resources Conservation Services. These data show soil map units delineated in the Bitterroot Valley. The survey is complete through much of the northern portion of

Ravalli County above Hamilton, with some incomplete areas primarily on the east side of the valley.

The list of 'Prime and other Important Farmlands' links map units in the soil survey with their farmland classification including: 'prime farmland,' 'farmland of statewide importance,' and 'farmland of local importance.'

Irrigated Lands – (State Engineer's Office)
These data are based on the 1958 Water Resources Survey for Ravalli County, Montana published by the State Engineer's Office. The data set was created by scanning and digitizing irrigated or irrigable lands shown in maps from this document into a GIS environment.

V. Open Lands Submodel

Bitterroot Important Bird Area – (Montana Audubon Society) (See Wildlife Resources Submodel)

Blodgett Important Bird Area – (Montana Audubon Society) (See Wildlife Resources Submodel)

National Wildlife Refuges – (Montana Natural Heritage Program) (See Wildlife Resources Submodel)

Parks – (Ravalli County GIS Department)
These data were developed by the Ravalli County GIS Department using data from the Montana Cadastral Mapping Project for Ravalli County (2007) and local input to identify parcels that are used as parks in Ravalli County. The field 'TYPE' includes the following values; 'Community', 'Conservation', 'Neighborhood (Neighborgood)', and 'Pocket'. The field 'OWNER' includes the following values; 'City', 'County', 'Private', 'School', 'Town', and 'US'. Values in the field 'GEOCODE' corresponds to values in the 'PARCEL_ID' field in the Cadastral data set. The parcel boundaries shown in this data set may vary from those shown in the Cadastral data set because the boundaries may have been modified slightly to better match property boundaries shown in 2004 color aerial photographs of Ravalli County.

Stewardship Easements – (Montana Natural Heritage Program)
These data and metadata were developed by the Montana Natural Heritage Program and are available online at (http://www.nris.mt.gov/gis) and directly from the Montana Natural Heritage Program. The data were developed using data from the Montana GAP Stewardship data from the University of Montana Wildlife Spatial Analysis Lab, surface management status data from the Bureau of Land Management, Montana Cadastral Mapping project data from the Montana Department of Administration, and national hydrography data from the U.S. Geological Survey. The data show the locations of lands in Montana with conservation easements.

Stewardship Leases – (Montana Natural Heritage Program)
These data and metadata were developed by the Montana Natural Heritage Program and are available online at (http://www.nris.mt.gov/gis) and directly from the Montana Natural Heritage Program. The data were developed using data from the Montana GAP Stewardship data from the University of Montana Wildlife Spatial Analysis Lab, surface management status data from the Bureau of Land Management, Montana Cadastral Mapping project data from the Montana Department of Administration, and national hydrography data from the U.S. Geological Survey. The data show the locations of lands in Montana with conservation leases.

Stewardship Owners – (Montana Natural Heritage Program)
These data and metadata were developed by the Montana Natural Heritage Program and are available online at (http://www.nris.mt.gov/gis) and directly from the Montana Natural Heritage Program. The data were developed using data from the Montana GAP Stewardship data from the University of Montana Wildlife Spatial Analysis Lab, surface management status data from the Bureau of Land Management, Montana Cadastral Mapping project data from the Montana Department of Administration, and national hydrography data from the U.S. Geological Survey. The data show the locations of lands in Montana that are 'managed by public agencies, private lands within government designate areas such as national forests, and private lands that are under conservation easements or conservation leases.'

Ravalli County Parcel Data – (Montana Cadastral Mapping Project)
These data and metadata were developed by the Montana Cadastral Mapping Project and are available online at (http://gis.doa.mt.gov/). Some of the data included in the attribute table for this data set includes the following:

- The type of property for tax purposes such as 'farmstead rural', 'agricultural rural', and others
- The type of ownership such as 'private', 'local government', and others
- The number of irrigated acres
- Parcel size

VI. Public Health and Safety Submodel

Wildfire Hazard – (US Forest Service)
The fire hazard model is based on a Forest Service product known as the Fire Behavior Assessment Tool, or FBAT. FBAT runs within ArcMap and incorporates a variety of spatial data inputs relevant to fire behavior, including vegetation, topography and wind speed. When estimating the behavior of a hypothetical fire, fire managers frequently refer to an FBAT output called fire line intensity. Fire line intensity attempts to quantify the amount of energy being released by an advancing fire as it moves across the ground. It is measured as kilowatts of energy per meter of ground distance per second.
The Forest Service has established three classes of fire line intensity (Jones, pers. comm., 2007). Using this guidance, the output was classified such that all areas less than 328 kW/m/s were interpreted as having a low fire hazard and were assigned a 'most suitable' development rating. Areas having a fire line intensity between 328 and 3,280 kW/m/s are considered as having moderate fire hazard and were given a 'moderately suitable' rating.

A fire line intensity above 3,280 kW/m/s is considered to represent dangerous fire behavior, and a 'least suitable' rating was assigned to these areas. According to researchers, a fire releasing energy at a rate greater than 3,280 kW/m/s is beyond the direct control of firefighters. This is the threshold above which human life and property are at much greater risk.

Slope – (USGS)
The Ravalli County planning regulations stipulate that no development may occur on slopes greater than 25%, unless there are mitigating circumstances (Ravalli Planning Department, pers. comm., 2007). For the public health and safety submodel, the USGS 30-meter digital elevation model was analyzed for percent slope. All pixels with 25% or greater slope are classified as 'least suitable,' and all other areas are 'most suitable.'

Floodplain – (FEMA) (See Water Resources Submodel)

Dam Breach Floodplain – (DNRC)
Included in the Public Health and Safety submodel is the delineation of the Ravalli County dam failure floodplain. This layer estimates the extent of the valley that might be inundated by an upstream dam breach (MDNRC, 2004). Since a dam failure flood is much less likely to occur than a natural flood, the layer is given a value of 'moderately suitable' for development instead of 'least suitable' so as to reduce its effect on the entire submodel.

Septic Suitability – (NRCS)
The septic suitability of any given soil type depends on a variety of properties relating to texture, drainage and depth to groundwater (Montana NRCS, pers. comm., 2007). The Natural Resources Conservation Service (NRCS) compiles such information in Soil Survey Geographic (SSURGO) databases. A SSURGO for Ravalli County has been completed for the area north of Hamilton. The NRCS has created a GIS-based tool called the Soil Data Viewer (SDV) to assist with querying the SSURGO database and to facilitate map creation. The SDV contains a septic suitability query that is specifically designed to guide the siting of septic tank facilities. While running this query, the SDV evaluates all of the soil mapping units for septic suitability and assigns each one a limitation rating. In the public health and safety submodel, areas rated "not limited" in the SSURGO were given a development suitability value of 'most suitable.' Areas rated "somewhat limited" were given a value of 'moderately suitable,' and areas rated "very limited" were assigned a value of 'least suitable.' Based on the recommendation of the NRCS, a conservative valuation of "somewhat limited" was applied to all areas in Ravalli County that are not covered by the SSURGO. In the public health and safety submodel this translates to the 'moderately suitable' class. These classifications can be reevaluated when the SSURGO has been completed for the entire county.

VII. Miscellaneous

Ravalli County Boundary – (State)

These data were developed by the Montana Department of Administration, Information Technology Services Division, GIS Bureau. The data displays the geographic extents of Ravalli County.

VIII. Data Sets Not Used

These data sets were not included as part of the LSA for several reasons (insufficient detail, no differentiation among different areas, local experts advised against using them, out of date, etc.). However, some of these data sets may be useful if presented as stand-alone maps:

- USGS Surface water quality monitoring sites (USGS)
- Stream barriers (MTFWP)
- FWP streams (MTFWP)
- Westslope Cutthroat Trout Conservation Areas (MTFWP)
- Whitetail Deer - Winter Range (MTFWP)
- Protected Streams – (MTFWP)
- Dewatered Streams – (MTFWP)
- Land Cover Data Set – (USGS and USEPA)
- Whitetail Deer Overall Distribution and Yearlong Range (MTFWP)
- Wolf Distribution (MTFWP)
- Turkey Distribution (MTFWP)
- Spruce Grouse Distribution (MTFWP)
- Ruffed Grouse Distribution – (MTFWP)
- Pheasant Habitat – (MTFWP)
- Gray Partridge Distribution – (MTFWP)
- Blue Grouse Distribution – (MTFWP)
- Black Bear Distribution – (MTFWP)
- Ponds – (Ravalli County GIS Department)
- National Hydrography Dataset – Point – (USGS and USEPA)
- Wildlife Management Areas – (MTFWP)
- Roads – (U.S. Bureau of Census)
- Roads – (Ravalli County GIS Department
- Bridges, Wildlife Crossings, Other Crossings – (MDT)
- Canals – (Ravalli County GIS Department)
- Structures – (Ravalli County GIS Department)
- Groundwater Wells – (Groundwater Information Center)
- Water Rights – Montana Department of Natural Resources
- Surficial Geology – (Montana Bureau of Mines and Geology)
- State Parks (MTFWP)
- Montana Terrestrial Focus Areas 2005, All Tiers (MTFWP)
- Fish, Wildlife and Parks owned Land (MTFWP)
- Utility Lines – (NorthWestern Energy)

Appendix B – Report Summaries

Supporting documents and reports used for each submodel are summarized below.

I. Existing Infrastructure Submodel

City of Hamilton FY 2004-2008 Growth Policy. The City of Hamilton Planning Board drafted the Growth Policy, which was adopted by the City Council in 2003. The Policy outlines a vision to help achieve and maintain public health and safety, economic prosperity, environmental well-being, the spirit of the community, diversity, natural beauty, history, and culture. Page 3-2 of the Policy states: "The City has a Planning Area that extends several miles beyond the city limits in all directions." Map 5 of the Policy shows the extent of the Planning Area. The City Planner recommended that the 20-Year Planning Area be rated as high suitability for development.

City of Hamilton 2006 Wastewater Facility Plan. Within this plan, there is a Sewer Planning Area that was determined by public input, ability for gravity service, and other geographic features. The Sewer Planning Area does not cross the Bitterroot River because of the anticipated costs of extending sewer across the Bitterroot River and the potential problems with an exposed line across the Main Street Bridge. Because the Sewer Planning Area is within the 20-Year Planning Area from the City of Hamilton's Growth Policy, it was not an additional layer in the Existing Infrastructure Submodel.

Old Corvallis Road Area 3 Neighborhood Plan, Ravalli County Growth Policy Amendment (2006). In January of 2005, Ravalli County and the City of Hamilton entered into an inter-local agreement and retained Community Concepts to prepare a Neighborhood Plan for consideration by the County and City for an area known as Service Area 3 of the Hamilton Water/Sewer system. In November of 2006, Ravalli County adopted the plan as an amendment to the Ravalli County Growth Policy. The City of Hamilton did not adopt the plan. Because the plan boundary is within the 20-Year Planning Area from the City of Hamilton's Growth Policy, it will not be an additional layer in the Existing Infrastructure Submodel.

Ravalli County Airport Influence Area Regulations and Ravalli County Airport Layout Plan. The Airport Influence Area Regulations were adopted November 20, 2003. There is a map showing the extent of the Airport Influence Area (AIA). There are height restrictions in the Visual Approach Zone, Non-precision Instrument Approach Zone, Transitional Zone, Horizontal Zone, and Conical Zone. Since the GIS Land Suitability Analysis will determine suitability for development intensity and not suitability for various building heights, these zones will not be included in the analysis.

There are land use restrictions in Land Use Districts A and B. Permitted Uses in Land Use District A, which is an area that encompasses the 75 DNL or greater noise contour as delineated in the Official Airport Layout Plan, are agriculture and airport infrastructure. Residential development is not permitted in District A. Land Use District B, which is defined as the area within the 65 to 75 DNL noise contour, allows for agriculture, open space, public parks, and industrial use. Wholesale trade, retail trade, eating and drinking establishments, and residential uses can be conditionally permitted. Digital files of the land use districts are not currently available. There are hard copy maps in the Clerk and

Recorder's Office and the Airport Manager is working with Morrison-Mairle to get the digital files. The County is in the process of performing an Environmental Assessment to improve and relocate the existing runway facilities.

Since there is no available digital data for the land use districts and there is the potential for the runway to move, Ravalli County Airport data was not be included in this analysis.

Town of Stevensville Street Master Plan (2006). The Town of Stevensville contracted Professional Consultants, Inc. to develop a Street Master Plan and Planned Growth Area. This Plan provides guidance to the town in the development of future road networks. A map within the plan shows the limits of the Planned Growth Area. Since this was more up to date than the Growth Policy for the Town of Stevensville or the Water and Sewer Plan, the Planned Growth Area from the Street Master Plan was rated as high suitability for development.

Town of Stevensville Water & Sewer Master Plan, 2003. This plan was prepared by Professional Consultants, Inc. to consider areas of potential development within town limits and within a defined service area. Within the report, there is a Master Planned Area, which appears to be the defined service area for extension of future water and sewer lines. The Master Planned Area varies from the Planned Growth Area from the Town of Stevensville Street Master Plan, 2006, but the Master Planned Area is contained within the Planned Growth Area. Because the Master Planned Area is within the Planned Growth Area, it was not an additional layer in the Existing Infrastructure Submodel.

Town of Stevensville Comprehensive Plan, 2002, and Development Code Book, 2007. Since Ravalli County has not yet adopted zoning regulations within one mile of Stevensville, the Town created an extraterritorial zoning district extending one mile south of the current town limits. The *Development Code Book* states: "It has been determined that the area to which the zoning and subdivision regulations of the Town of Stevensville should be extended is that land lying between the Supply Ditch canal and the Bitterroot River, south of the existing southerly boundary of the Town of Stevensville and its existing additions, and extending south there from for a distance of one mile, excluding Ravalli County Holly Lane Zoning District No. 23." The Comprehensive Plan states: "[The extraterritorial zoning district] represents one of the most logical areas in which to extend urban services, and therefore it is eligible for annexation." Since the Stevensville Extraterritorial Zoning Boundary is within the Planned Growth Area from the Master Street Plan, it was not be an additional layer in the Existing Infrastructure Submodel.

Zoning Ordinance to Limit Height of Objects and Land Use around the Stevensville Airport (2001). The ordinance created the Utility Runway Visual Approach Zone, Transitional Zones, Horizontal Zone, and Conical Zone. There are various height restrictions in each zone. Section V outlines the following use restrictions: "Notwithstanding any other provisions of this Ordinance, no use may be made of land or water within any zone established by this Ordinance in such a manner as to create electrical interference with navigational signals or radio communication between the airport and aircraft, make it difficult for pilots to distinguish between airport lights and

others, result in glare in the eyes of pilots using the airport, impair visibility in the vicinity of the airport, create bird strike hazards, or otherwise in any way endanger or interfere with the landing, takeoff, or maneuvering of aircraft intending to use the airport. No use may be made land or water within any zone established by this Ordinance which receives an objectional determination in response to the notice requires to be filed under Federal Aviation Regulations parts 157 or Part 77." While the document lists height restrictions, it does not give specific guidance on land uses or development densities surrounding the Stevensville Airport. Staff was not able to determine how development suitability should be rated in the area surrounding the airport so this was not included in the Existing Infrastructure Submodel.

Tin Cup County Water and/or Sewer District. The Tin Cup Water District was created on July 16, 1997 to secure financing for repairs to and maintenance of the dam located at the outlet to Tin Cup Lake. Area residents were concerned that if the repairs were not made, the Forest Service would not let them continue to use irrigation water from Tin Cup Lake. An attorney advised the residents to pursue a water district instead of an irrigation district because "it could be tied up in court and those kinds of districts are outdated as they do not allow enough flexibility with water usage." (BCC Public Hearing Minutes dated July 15, 1997) Because the District was created for irrigation purposes and not for public infrastructure in response to growth, this boundary was not used in the Existing Infrastructure Submodel.

Florence Sewer and Water District Boundary. The District was formed on August 1, 1977. Currently, there is not any infrastructure associated with this District. There was a recent effort to construct a public sewer system, but due to community opposition, the project was never finished.

II. Water Resources Submodel

2006 Integrated 303(d)/305(b) Water Quality Report for Montana (2006). This is a report that is completed every two years to satisfy requirements of federal Clean Water Act sections 303(d) and 305(b). The report includes the process, methods, and findings of water quality assessments throughout the state of Montana (Montana DEQ 2006). The complete 303(d) list of impaired waters is included in Appendix H of the document. The Upper Clark Fork Watershed, including the Bitterroot River Watershed, is in Section 2 of Appendix H.

III. Wildlife Resources Submodel

Highway 93 Corridor Wildlife Memorandums (2007). These draft memorandums were developed by The University of Montana School Of Law's Land Use Clinic (Land Use Clinic 2007). The memorandums describe different options for protecting land around wildlife crossing structures installed along U.S. Highway 93 to decrease vehicle and animal collisions. This information is intended to be used for overlay zoning planning after baseline zoning is complete. Thorough literature reviews within the memorandums document recommended wildlife corridor widths that vary by species. The Land Use Clinic's recommendations do support using riparian corridors as part of the Wildlife Resources submodel, but the recommendations have not been incorporated

into official policy, are not available is a spatially usable format, and the scale of recommended buffers or setbacks is small enough that the one-acre pixel resolution of the model would accurately represent their intent.

Montana Comprehensive Fish and Wildlife Conservation Strategy (2005). This report is part of a nationwide effort to develop comprehensive assessments of fish and wildlife species and the areas they inhabit (Montana Fish, Wildlife and Parks 2005). The report identifies wildlife species and habitats in Montana that have the greatest conservation needs. The Bitterroot Valley is a 'Tier I Terrestrial Conservation Focus Area in Greatest Need'. Wetlands and riparian areas in the Bitterroot Valley are identified as 'Tier I' habitats, meaning that the focus area, habitat or species referenced has the greatest need for conservation.

Coordinated Implementation Plan for Bird Conservation in Western Montana (2005). This plan, produced by the Intermountain West Joint Venture (IWJV), Montana Steering Committee, describes the state plan for implementing bird conservation efforts from the *North American Waterfowl Management Plan* (NAWMP) in western Montana (IWJV 2005). This plan updates a 1995 plan and coordinates objectives from the NAWMP, the Joint Venture and other bird conservation efforts in the region to create a planning document reflecting coordinated species and habitat priorities of bird conservation programs in Montana. The report identifies riparian and wetland areas as priority habitats in the Bitterroot Valley Bird Habitat Conservation Area. The report classifies deciduous forest and shrubland riparian areas and wetlands as 'Priority A' – "High threat, high opportunity, and high value to birds statewide." This supports emphasizing riparian and stream corridors within the Wildlife Resources submodel.

IV. Working Lands Submodel

Bitterroot Valley Agriculture Study (2006). In 2006, The University of Montana's Center for the Rocky Mountain West completed a study assessing the state of agriculture in the Bitterroot Valley (Swanson 2006). Recommendations included focusing development near population centers, clustering development in rural areas (leaving significant open space), integrating pasture commons (functioning agricultural areas within developments) as part of development, implementing an open space bond that includes agricultural lands as a primary objective, and preserving water resources by establishing streamside setbacks for new development. While many of the recommendations in the report are specific to later phases of zoning, the report provides broad justification for identifying important agricultural areas as part of the LSA.

V. Open Lands Submodel

Ravalli County Open Lands Bond Program: A Guide for Applicants and Sponsoring Organizations or Agencies (2007): This document, available at http://www.co.ravalli.mt.us/planning/documents/OLBGuideforApplicantsFINAL.pdf, provides guidance and criteria established by the Ravalli County Open Lands Board. The Open Lands submodel incorporates some of the criteria from this document.

VI. Public Health and Safety Submodel

Bitterroot Valley Community Wildfire Protection Plan (2003). This document was prepared by the Bitterroot Resource Conservation & Development Area (BRRCD), Inc. with assistance from the USDA Forest Service and Montana DNRC. The stated goal of the report is to protect Ravalli County residents and natural resources from catastrophic wildfire while at the same time promote the natural role of fire in the ecosystem. The report outlines plans for fuel reduction projects and restoration of damaged areas, as well as ideas for better cooperation among fire management agencies. The document and accompanying maps can be viewed at http://www.bitterrootfireplan.org/.

Ravalli County Pre-Disaster Mitigation Plan (2004). This document was prepared by Land and Water Consulting of Missoula, Montana. The stated goal of the report is to identify potential natural disasters that may affect the county and profile each hazard in terms of life and property losses. The report also includes analyses of possible mitigation projects that can reduce the threat to the population. The natural hazards profiled in the report include earthquake, flooding, wildfire, landslides, extreme storms and volcanic eruptions.

VII. Miscellaneous

Ravalli County Growth Policy (2002—amended 2004). Excerpted from the Growth Policy Introduction: "The Ravalli County Growth Policy is designed to establish a comprehensive set of long-range goals and goal-related policies to guide future growth and development. It seeks to provide an increased level of predictability to land owners, neighbors and developers about where and how growth can be accommodated in ways that are compatible with fiscal and environmental concerns. It is designed to guide growth toward areas where it is expected and where it can be accommodated. In that sense, it seeks to promote desired, sustainable growth." As noted above, the Growth Policy provides guidance for long-range planning, and the LSA is based in part on this guidance (http://www.ravallicounty.mt.gov/planning/growthpolicy.pdf).

Appendix C – Meeting Summaries

Corvallis Sewer District. In December of 2007, Planning staff had a phone conversation with Roger DeHaan, consulting engineer for the Corvallis Sewer District. He stated that there are no plans for expanding the current infrastructure or sewer district boundary.

Ravalli County Airport Officials. In December of 2007, Planning staff met with airport officials to discuss how suitable the areas surrounding the airport are for development. There was discussion about the Airport Influence Area, height restricted zones, and land use restricted zones. The Airport Manager is in the process of obtaining digital files of this information from Morrison-Mairle. There was also discussion that the runway may be moved slightly. Because there is no digital data and the runway may be relocated, the Ravalli County Airport was not considered in the LSA.

City of Hamilton. In December of 2007, Planning staff met with Dennis Stranger, City of Hamilton Planner, to discuss how existing municipal infrastructure and future plans for expansion should be included in the Land Suitability Analysis. The City of Hamilton Growth Policy and 2006 Wastewater Facility Plan were reviewed. HDR, Inc., consulting engineer for the City, was consulted via phone. Dan Harmon, HDR, Inc., stated that the Hamilton Sewer Planning Area within the 2006 Wastewater Facility Plan was determined by public input, ability for gravity service, and geographic features. The Sewer Planning Area does not cross the Bitterroot River because of the anticipated costs of extending sewer across the Bitterroot River and the potential problems with an exposed line across the Main Street Bridge. Mr. Stranger discussed the potential for extending sewer to the area west of Hamilton by burying the lines beneath the River. There was also discussion about the potential for constructing a smaller system across the River that would separate from the existing wastewater infrastructure for the City. There was also discussion about the 20-Year Planning Area within the Growth Policy. The 20-Year Planning Area contains the Sewer Planning Area. HDR, Inc. did not know how the 20-Year Planning Area was generated. Mr. Stranger recommended that the 20-Year Planning Area be rated as high suitability for development because it is in the adopted Growth Policy and is the best available data.

Ravalli Electric Cooperative. In December of 2007, Planning staff had a phone conversation with Allan Lear, Field Engineer for the Ravalli Electric Cooperative. Mr. Lear stated that there is nothing that would prevent a property from getting service from the Ravalli Electric Cooperative.

Natural Resource Conservation Service (NRCS). On November 9, 2007, Geum Environmental Consulting, Inc. (Geum) and Ravalli County Planning staff met with Jay Skovlin and Beth Rowley, NRCS Soils Survey staff. The group discussed the most appropriate ways to use soil survey data as criteria for several of the submodels. In particular, discussions focused on how to interpret hydric soils and important farmland soils designations in a manner that would be meaningful for determining land use suitability. Specific recommendations from NRCS staff resulting from this meeting included the following:

- Drainage modifiers (such as 'somewhat poorly drained' as a threshold) might indicate shallow groundwater or help interpret a hydric modifier.
- The surficial geology map (Lonn and Sears 2001) provides an excellent geomorphic context for interpreting soils.
- NRCS staff will continue to work on developing/interpreting data to support countywide zoning.

Based on the results of this meeting, and subsequent communications with NRCS staff, hydric soils were included as part of the Water Resources submodel, and criteria were developed related to septic suitability to support the Public Health and Safety submodel (described in a separate report). The surficial geology map may be useful as a stand-alone map, but it did not fit as part of the submodels.

NorthWestern Energy. In December of 2007, Planning staff had a phone conversation with Justin Merkel, the Hamilton Operations Supervisor for NorthWestern Energy. He stated that they will supply any property with service. He stated that it is easier to connect to new development with existing lines and that other existing infrastructure, such as public water and sewer, would indicate that there is a higher level of power capacity in that area.

Ravalli County Fish and Wildlife Association. On November 12, 2007, Geum attended a Ravalli County Fish and Wildlife Association Board meeting. Ravalli County Planning staff also attended the meeting and described the overall planning process for countywide zoning. After reviewing existing spatial data related to wildlife, the group offered several thoughts about wildlife factors that would be important to consider in a countywide zoning effort. These factors include the following:

- Elk and mule deer winter range are important and should be given priority for inclusion in the Wildlife submodel;
- Effects of wolves on wildlife distributions should be considered;
- Mule deer range is shifting so there is more summer use in the valley bottom;
- The number of species whose ranges overlap within a particular area could be an appropriate way to weight the suitability analysis; and
- Bighorn sheep winter range likely includes south-facing cliffs which are not shown in the existing spatial data set.

Based on input from Ravalli County Fish and Wildlife Association and others, winter range was included as one of the most important factors related to wildlife habitat in the LSA. Other information, such as shifting wildlife ranges, is important to consider as part of the countywide zoning process, but was not included in the LSA because there are no spatial data sets that illustrate these trends.

Bitter Root Land Trust. On November 13, 2007, Geum met with the Bitter Root Land Trust's Lands Committee. The Lands Committee includes as members John Vore, MTFWP Biologist, and John Ormiston, retired USFS Biologist. Comments included:

- Winter range and riparian areas are the most important data sets that would indicate important wildlife habitat and use areas;

- Useful criteria can be extracted from priorities identified in Montana's Comprehensive Fish and Wildlife Conservation Strategy (Montana Fish, Wildlife and Parks 2005);
- Criteria for the Ravalli County Open Lands Bond include some wildlife parameters, and these can be used for both the Wildlife and Open Lands submodels; and
- Some wildlife data from Montana Fish, Wildlife and Parks should be updated. John Vore indicated he would look into ways to update these data layers and increase their accuracy.

Recommendations from John Ormiston and John Vore (and Chris Clancy—see below), combined with input from Ravalli County Fish and Wildlife Association and other natural resources specialists, guided development of the Wildlife Habitat submodel. Riparian areas and winter range stood out as the most important criteria relative to wildlife habitat.

Right to Farm and Ranch Board. On November 14 and December 3, 2007, Geum met with representatives of the Right to Farm and Ranch Board. Discussions during this meeting focused on appropriate use of important farmlands soils, and resulted in Geum requesting specific definitions of the farmland soils categories. Suggestions resulting from this meeting included:

- Irrigated land is an important criteria for working lands (timing of water use, seniority of water rights, water quantities, and infrastructure or type of irrigation system);
- Locally important farmland soils should be considered as a strong criteria, along with prime farmland soil and farmland soil of statewide importance;
- Using Department of Revenue property tax categories is an appropriate way to identify land currently being used for agriculture;
- Working Lands should include lands used for timber production; and
- Clusters of working lands should be incorporated as important criteria, but the nature of distributed land use in the valley means it is also acceptable for working lands to be integrated with rural residential areas.

Based on these recommendations, the working lands submodel is based primarily on Important Farmland Soils, presence of irrigation, and current land use for agriculture. Locally important farmland soils were considered differently from prime farmland soils and farmland soils of statewide importance in order to be consistent with formal definitions of these classes.

Ravalli County Board of Health. On December 13, 2007, Geum met with Roger DeHaan, a local civil engineer who also sits on the Ravalli County Environmental Health Board. Suggestions and observations included:

- Irrigation ditches throughout Ravalli County impact shallow groundwater levels. These effects to groundwater can also be changed if there are modifications to the irrigation ditches;

- Sub-division regulations for septic require that seasonal groundwater be at least 48 inches below the ground surface. If seasonal groundwater is below 48 inches, then other factors including soil texture are considered in the septic suitability analysis;
- Percolation tests for septic suitability typically range from 5 to 30 for good suitability;
- Groundwater well data from the Groundwater Information Center (GWIC) can be used to show the static water level in the well; however, wells that show '0' for the static water depth may indicate no data or unavailable data;
- Groundwater well yield data in gallons per minute (gpm) may also be useful information related to development planning. Regulations require wells to produce at least 8 gpm for residential development;
- The surficial geology layer shows some areas that tend to be productive aquifers such as areas identified as 'Fluvial gravel of the ancestral Bitterroot River channel' (Tbg) (Lonn and Sears 2001). These productive aquifers tend to be located on the east side of the Bitterroot Valley and as you move further east outside of this surficial geology zone, the aquifer may be less productive. In some of these areas with less productive aquifers, there will be pockets or groundwater, but they take a long time to recharge once they have been utilized.

Ravalli County Environmental Health Department. On December 13, 2007, Geum met with Lea Jordan, director of the Ravalli County Environmental Health Department. Suggestions included:

- Ground Water Information System (GWIC) data including well yields (gpm) or drawdown rates may be useful sources of data for interpreting groundwater supply;
- Source water assessments for public supply were completed by the Montana Department of Environmental Quality and may have data related to groundwater supply and possibly the quality of groundwater resources;
- The Ravalli County Environmental Health Department has data from deep soil pit examinations in paper format, but these data are not compiled;
- Some groundwater monitoring well locations have been recorded with GPS devices and well log data is available.

Meetings with the Health Board and Environmental Health Department described above resulted in identification of data gaps. The Environmental Health Department is currently developing plans to fill data gaps related to groundwater vulnerability, and there have been several community discussions and presentations related to water quality that should be considered during the Countywide zoning process.

Town of Darby. In December of 2007, Planning staff had a phone conversation with the Mayor of Darby, Rick Scheele. He stated that the Darby Planning Board has created a draft map outlining potential of the town limits. The map is in draft form and has not been through a public process or officially adopted, so it was not included in the LSA.

Town of Pinesdale. In December of 2007, Planning staff had a phone conversation with Rocky Weidow, Chairman of the Selectmen for the Town of Pinesdale. He stated that there are no plans for expanding town limits at this time.

United States Forest Service. On December 26, 2007, Geum received comments from Ed Snook, Bitterroot National Forest Hydrologist. Suggestions related to submodel development included:

- The Forest Service and MT FWP have cooperated in building a fish population database that would suggest where high value fisheries are located.
- The National Hydrography Dataset does not give information on channel or inner gorge characteristics that would affect suitability.
- Water information represented by lines (streams and ditches) should be buffered to account for the width of these resources;
- Total Maximum Daily Load (TMDL) issues may also be mitigated by various approaches, including riparian management plans. Streams on the 303(d) (TMDL) list for flow-related issues may not be a good determinant and may need to be broken out from streams on the list for sediment or nutrient issues.
- "Presence of shallow groundwater" information that is available would need supplementation with on-site groundwater monitoring. Some of the data gaps related to ground water monitoring data could be addressed by a Water Quality District.

Several of these suggestions and comments reinforced comments received from other individuals. The first comment about high value fisheries prompted consultation with Fish, Wildlife and Parks and resulted in modifying the criteria for important fish streams. Other comments should be considered in general with respect to land use planning in Ravalli County.

Victor Sewer District. In December of 2007, Planning staff had a phone conversation with Roger DeHaan, consulting engineer for the Corvallis Sewer District. He stated that there are no plans for expanding the current infrastructure or sewer district boundary.

Montana Fish, Wildlife and Parks. During the week of December 17, 2007 John Vore, Wildlife Biologist, reviewed the Wildlife Resources submodel criteria and suggested adding an east-west corridor in the Eight Mile Creek area at the northern end of the County. Because this would require creating a new data layer, this was not included in the analysis.

On January 9, 2008, Chris Clancy, Fisheries Biologist, reviewed the Wildlife Resources submodel and provided an alternative list of important fish habitat streams. This suggested change was included in the analysis because it was possible to make the change by simply re-classifying existing data.

Appendix D – Detailed Submodel Criteria

Water Resources Submodel Criteria

Class 1. A pixel must meet any one or more of the following criteria. These are cells that represent the presence of water and water-related resources.

- NHD – Flowline, includes field 'FType' = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path' (NHDFlowline_WATER_WILDL.shp)
    - *Indicates the presence of surface water resources*
- NHD – Area with field 'FType' = 'StreamRiver' (NHDArea_WATER_WILDL.shp)
    - *Indicates the presence of surface water resources*
- NHD – Waterbody with field 'FType' = 'LakePond', 'Reservoir', or 'SwampMarsh' (NHDWaterbody_WATER_WILDL.shp)
    - *Indicates the presence of surface water resources*
- NWI (2007) wetland present (Wetlands_WATER_WILDL.shp)
    - *Indicates the presence of shallow groundwater or surface water*
- Bitterroot pilot wetlands mapping project wetland present (Ravalli_County_Wetlands_WATER_WILDL.shp)
    - *Indicates the presence of shallow groundwater or surface water*
- U.S. Forest Service wetlands present (usfs_wetland_WATER_WILDL.shp)
    - *Indicates the presence of shallow groundwater or surface water*
- MNHP riparian is present (Riparian_WATER_WILDL.shp)
    - *Riparian habitat that is integral with stream and river water resources*
- 100-year flood fringe or floodway is present (FEMA_Floodplain_100_FH_WATER_WILDL.shp or FEMA_Floodplain_100_FW_WATER_WILDL.shp)
    - *Regulated zone along the Bitterroot River where there are already development restrictions in place*
- NRCS Soils that are included on hydric soils and 50% of the map unit components are hydric (Soils_Hydric_GT50pct_WATER.shp)
    - *Indicates current or past presence of shallow groundwater resources that allowed the formation of hydric soils*
- Irrigation ditches are present (1958 layer) (Irrigation_Ditch_1958_WATER.shp)
    - *Irrigation ditches throughout Ravalli County influence groundwater levels and groundwater recharge.*

Class 2. A pixel must meet any one or more of the following and not meet the Class 1 criteria. These are cells that represent a water-related resource or an impaired water resource that may be limiting to further development in the watershed.

- If 'Attainment' in table 'WQS_Attainments' = 'N' (Not Supporting) (subwatersheds_w_303dstreams_WATER.shp)
    - *The sub-basin (6th code HUC) containing the identified stream or stream reach is selected to indicate that water quality in the sub-basin is impaired and additional development in the sub-basin may need to be evaluated differently than other areas*
- The 500-year flood hazard is present (FEMA_Floodplain_500_FH_WATER_WILDL.shp)
    - *This is not regulated, but is delineated for the Bitterroot River and is an area that may be periodically impacted by flood flows*

Class 3. These are pixels that do not meet any of the criteria listed above for classes 1 or 2.

Wildlife Resources Submodel Criteria

Class 1. A pixel must meet any one or more of the criteria below. These are cells that represent the presence of important wildlife species range or habitat.

- NHD Flowline is present (includes all streams so it also includes bull trout critical habitat, westslope cutthroat trout conservation areas, protected streams and dewatered streams) - 'FType' = 'StreamRiver', 'CanalDitch', 'Connector', 'Pipeline', or 'Artificial Path' (NHDFlowline_WATER_WILDL.shp)
    - *Indicates habitat for fish and aquatic species as well as a resource used by terrestrial mammals*
- NHD – Area with field 'FType' = 'StreamRiver' (NHDArea_WATER_WILDL.shp)
    - *Indicates habitat for fish and aquatic species as well as a resource used by terrestrial mammals*
- NHD – Waterbody with field 'FType' = 'LakePond', 'Reservoir', or 'SwampMarsh' (NHDWaterbody_WATER_WILDL.shp)
    - *Indicates habitat for fish and aquatic species as well as a resource used by terrestrial mammals*
- MNHP riparian is present (Riparian_WATER_WILDL.shp)
    - *Indicates habitat for aquatic species, reptiles and amphibians as well as a resource used by terrestrial mammals*
- National Wetlands Inventory (2007) present (Wetlands_WATER_WILDL.shp)
    - *Indicates habitat for aquatic species, reptiles and amphibians as well as a resource used by terrestrial mammals*
- Bitterroot Wetlands (2005) present (Ravalli_County_Wetlands_WATER_WILDL.shp)
    - *Indicates habitat for aquatic species, reptiles and amphibians as well as a resource used by terrestrial mammals*
- U.S. Forest Service wetlands present (usfs_wetland_WATER_WILDL.shp)
    - *Indicates habitat for aquatic species, reptiles and amphibians as well as a resource used by terrestrial mammals*
- Bitterroot IBA (bitt_iba_WILDL.shp)
    - *Indicates important bird areas identified by the Audubon Society*
- Blodgett IBA (blodgt_iba_WILDL.shp)
    - *Indicates important bird areas identified by the Audubon Society*
- National Wildlife Refuges (nwr_WILDL.shp)
    - *Indicates managed and protected wildlife habitats*

Class 2. A pixel must meet any one or more of the criteria below. These are cells that represent the presence of important wildlife species range, primarily winter range.

- Bighorn sheep distribution – 'BSH_USE" contains 'W' (winter range) (sheep2003_winter_WILDL.shp)
    - *Indicates areas used during winter months*
- Mule deer distribution – 'Class' contains 'D' (winter range) (MuleDeer2004_winter_WILDL.shp)
    - *Indicates areas used during winter months*
- Moose distribution – 'USE' contains 'W' (winter range) (moose_winter_WILDL.shp)
    - *Indicates areas used during winter months*

- Mountain goat distribution – 'USE' contains 'W' (winter range) (goats2002_winter_WILDL.shp)
    - *Indicates areas used during winter months*
- Elk distribution – 'WCRUCIAL' = 'C' (crucial winter range) or 'WINHAB' = 'Y' (winter range) (elk99_winter_WILDL.shp)
    - *Indicates areas used during winter months*

Class 3. A pixel must meet any one or more of the criteria below and not meet the Class 1 criteria. These are cells that represent an area containing a protected or impaired wildlife habitat feature that may be limiting to further development in the watershed. *Subwatersheds with protected or dewatered streams have been removed from this submodel. Subwatersheds with bull trout critical habitat and westslope cutthroat trout have been revised and replaced with the highlighted files below. Subwatersheds with important rainbow and brown trout spawning have been added to the submodel.*

- Core bull trout critical habitat present within the subbasin (6th code HUC) (subwatersheds_w_bulltrout_CORE_critical_habitat_WILDL.shp)
    - *Indicates the presence of core, legally protected habitat within the subwatershed*
- Important spawning streams for fluvial westslope cutthroat trout within the subbasin (6th code HUC) (subwatershed_w_fluvial_wsct_spawning_WILDL.shp)
    - *Indicates the presence of westslope cutthroat trout spawning habitat*
- Important spawning streams for rainbow and/or brown trout within the subbasin (6th code HUC) (subwatershed_w_rainbow_brown_spawning_WILDL.shp)
    - *Indicates the presence of rainbow and/or brown trout spawning habitat*
- Floodplain (100 Year Floodway, 100 Year Flood Fringe or 500 Year Flood Hazard) is present (FEMA_Floodplain_100_FH_WATER_WILDL.shp, FEMA_Floodplain_100_FW_WATER_WILDL.shp, or FEMA_Floodplain_500_FH_WATER_WILDL.shp)
    - *Indicates habitat for aquatic species, reptiles and amphibians as well as a resource used by terrestrial mammals*

Class 4. These are pixels that do not meet any of the criteria listed above for classes 1 or 2.

Working Lands Submodel Criteria

Class 1. These are pixels that represent the presence of rural working lands and resources that support working lands with prime or statewide important soils. If **either** Cadastral condition is present **and** both the farmland soils and irrigation water conditions are true, then a cell is Class 1. One shapefile represents the criteria below (workingland_and_primestate_and_irrigation_WORK.shp).

Lands that are classified as farms or ranches

{

- Cadastral data 'PROPTYPE' field is any of the following: 'agricultural rural', 'farmstead rural', 'agricultural urban

  OR
- Cadastral 'CONT_CROP'>0 OR 'FALLOW_ACR'>0 OR 'GRAZING_AC'>0 OR 'TIMBER_ACR'>0 OR 'WILD_HAY_A'>0

}

AND

Farmland soils based on designations assigned by the USDA NRCS

- NRCS Soils data show 'prime farmland' or 'soils of statewide importance'

AND

Irrigation water to support agricultural activities is present

- Irrigation water is present – based on Cadastral date 'IRRIG_ACRE' > '0' OR Irrigated land present (1958 data).

Class 2. These are pixels that represent the presence of rural working lands and resources that support working lands with locally important soils. If **either** Cadastral condition is present **and** both the farmland soils and irrigation water conditions are true, then a cell is Class 2. One shapefile represents the criteria below (Workingland_and_localsoil_and_irrigated_WORK.shp).

Lands that are classified as farms or ranches

{

- Cadastral data 'PROPTYPE' field is any of the following: 'agricultural rural', 'farmstead rural', 'agricultural urban

OR

- Cadastral 'CONT_CROP'>0 OR 'FALLOW_ACR'>0 OR 'GRAZING_AC'>0 OR 'TIMBER_ACR'>0 OR 'WILD_HAY_A'>0

}

AND

Farmland soils based on designations assigned by the USDA NRCS

- NRCS Soils data show 'locally important soils'

AND

Irrigation water to support agricultural activities is present

- Irrigation water is present – based on Cadastral date 'IRRIG_ACRE' > '0' OR Irrigated land present (1958 data).

Class 3. These are pixels that represent the presence of rural working lands, irrigation, or land with locally important soils. If **either** Cadastral condition is present **or** farmland soils are present **or** irrigation water conditions are true, then a cell is Class 3. One shapefile represents the criteria below (Workingland_or_irrigation_or_prime_or state_or_local_soil_WORK.shp).

Lands that are classified as farms or ranches

- Cadastral data 'PROPTYPE' field is any of the following: 'agricultural rural', 'farmstead rural', 'agricultural urban

OR

- Cadastral 'CONT_CROP'>0 OR 'FALLOW_ACR'>0 OR 'GRAZING_AC'>0 OR 'TIMBER_ACR'>0 OR 'WILD_HAY_A'>0

OR

Farmland soils based on designations assigned by the USDA NRCS

- NRCS Soils data show 'prime farmland', 'statewide important', or 'locally important soils'

OR

Irrigation water to support agricultural activities is present

- Irrigation water is present – based on Cadastral date 'IRRIG_ACRE' > '0' OR Irrigated land present (1958 data).

Class 4. These are pixels that do not meet any of the criteria listed above for classes 1 or 2.

Open Lands Submodel Criteria

Class 1. These are pixels that represent the presence of protected lands that, under current management, cannot or are not likely to be developed.

- Public lands, parks, conservation easements (Cons_Areas_OPEN.shp)
    - *Indicates the presence of large, mostly undeveloped land*

Class 2. A pixel must meet either of the criteria below and not meet the Class 1 criteria. These are cells that represent the presence of parcels that may meet some of the criteria identified in the open lands program.

- Parcel size >400 acres (individual parcels and contiguous parcels with same owners totaling >400 acres) (Cadastral_GT400_Parcels_OPEN.shp)
    - *Indicates the presence of large, mostly undeveloped land*
- A parcel is between 25 – 400 acres **AND** parcel is adjacent to an IBA, refuge, conservation easement, or public land (Cadastral_24_400NextTo_Cons_OPEN.shp)
    - *Indicates the presence of medium sized parcels that are next to existing open land*

Class 3. A pixel must meet the criteria for the first bullet (solid) and at least one of the sub-bullets (hollow). A raster cell also must not meet the Class 1 or 2 criteria. These are cells that represent the presence of parcels that may receive intermediate scores for some criteria in the Open Lands Bond Program.

- Parcel between 25 – 400 acres (individual parcels 25-400 acres and contiguous parcels with same owners totaling 25-400 acres) (Cadastral_25_400_Parcels_OPEN.shp)
    - Parcel does not touch, but is within 1 mile of IBA, refuges, conservation easements, or public lands
        - OR
    - Abuts working lands that are between 25 and 400 acres (Cadastral_20_400_1mile_Cons_OPEN.shp – both bullets above)
        - *Indicates the presence of medium sized parcels that are near existing open lands or next to working lands*

Class 4. These are pixels that do not meet the criteria for Classes 1, 2 or 3 and represent the presence of parcels that may receive lower scores for some criteria in the Open Lands Bond Program.

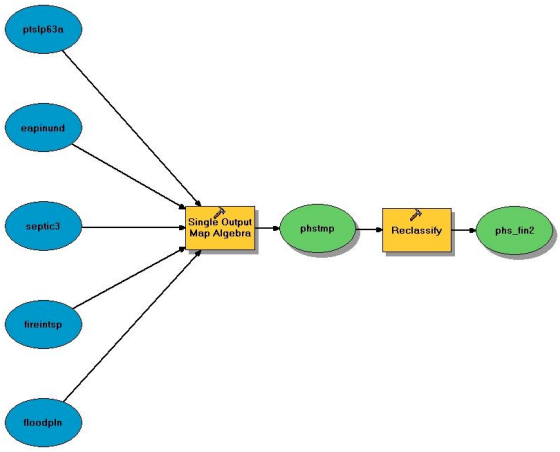
- Parcel between 25 – 400 acres (Cadastral_25_400_Parcels_OPEN.shp)
    - *Indicates medium sized parcels that are not close to other existing open lands*

Class 5. These are pixels that do not meet any of the criteria listed above for classes 1, 2, 3, or 4.

Appendix E – ModelBuilder Schematics and Data Descriptions

Much of the model creation methodology can be understood by simply exploring the models in ModelBuilder. Each icon can be double-clicked to reveal the 'behind-the-scenes' GIS processes involved. This sheet provides data layer explanations for the Public Health and Safety and Existing Infrastructure submodels, as well as the composite model used to combine all six submodels used in the Land Suitability Analysis. Descriptions of the data inputs for the Open Lands, Working Lands, Wildlife and Water submodels are provided in Appendix D of the LSA report; schematics can be viewed in ModelBuilder.

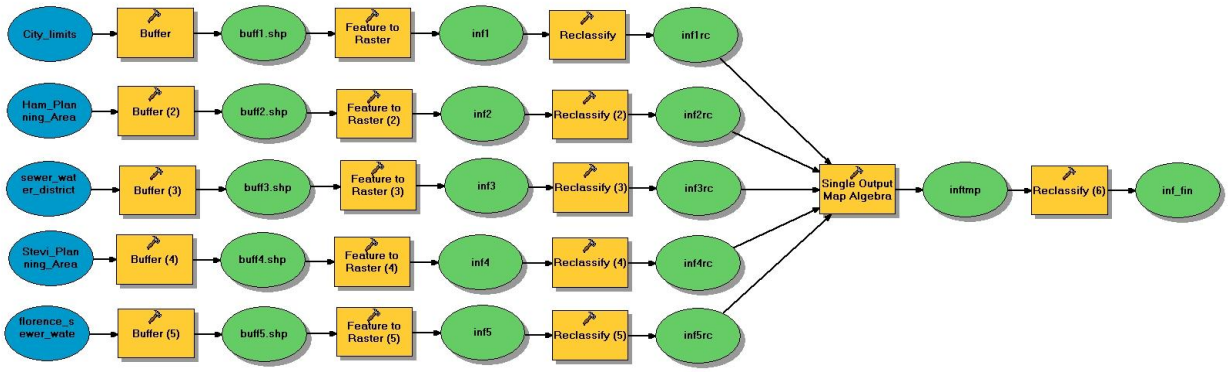
Public Health and Safety Submodel



ptslp63a: percent slope at 63m cell resolution
eapinund: Emergency Action Plan inundation area (dam breach floodplain)
septic3: septic suitability
fireintsp: fire intensity (hazard) state plane coordinate system
floodpln: 100- and 500-year FEMA floodplain

phstmp: public health and safety temp raster
phs_fin2: public health and safety final raster

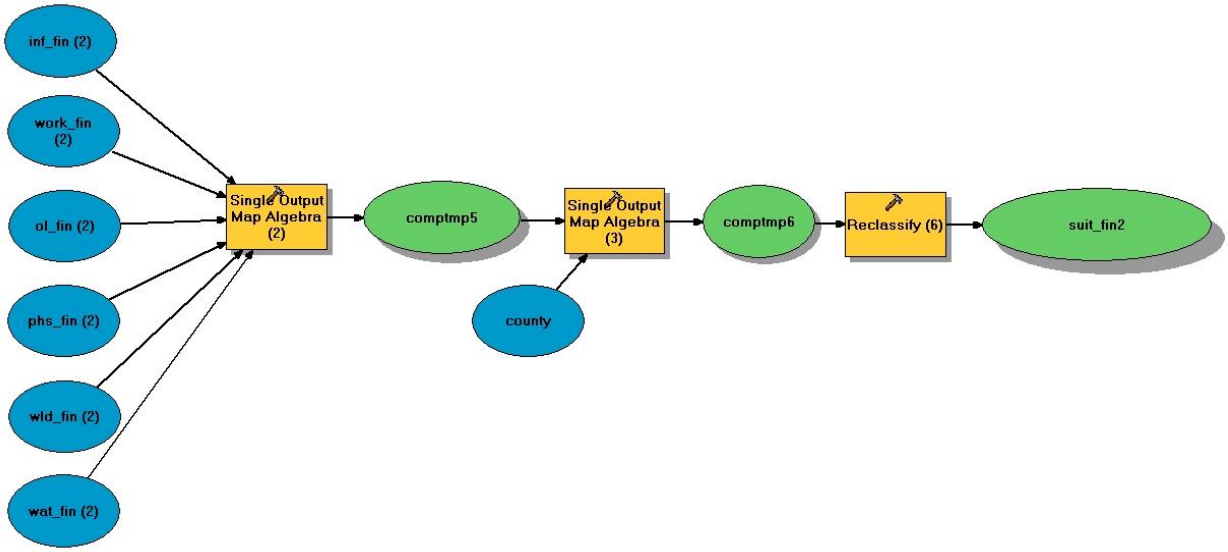
Existing Infrastructure Submodel



City_limits: all municipal city limit boundaries in Ravalli County
Ham_Planning_Area: Hamilton planning area
sewer_water_district: established district boundaries in Ravalli County
Stevi_Planning_Area: Stevensville planning area boundary
florence_sewer_water: Florence sewer and water district boundary

buff*x*: buffer of 32m added to ensure complete coverage when polygons are converted to raster
inf*x*: result of polygon to raster conversion
inf*x*rc: result of raster reclassification
inftmp: result of adding the infxrc rasters together
inf_fin: final infrastructure raster

Composite Suitability Model



inf_fin: final infrastructure raster
work_fin: final working lands raster
ol_fin: final open lands raster
phs_fin: final public health and safety raster
wld_fin: final wildlife resources raster
wat_fin: final water resources raster

comptmp5: initial composite raster - result of combining the final 6 suitability rasters
county: rasterized county boundary used for clipping
comptmp6: comptmp5 clipped to county boundary
suit_fin2: reclassified comptmp6 = final suitability raster